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WAR DEPARTMENT

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TECHNICAL MANUAL—ENEMY  
(GERMAN)

2-CM FLAKVIERLING 38  
(GERMAN 20-MM ANTIAIRCRAFT GUN,  
FOUR-BARRELED MOUNT)

April 1, 1943

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# **2-CM FLAKVIERLING 38 (GERMAN 20-MM ANTIAIRCRAFT GUN, FOUR-BARRELED MOUNT)**

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## **SECTION I**

### **GENERAL**

	Paragraph
Purpose and scope.....	1
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1. **Purpose and scope.**—*a.* This manual is published for the information and guidance of the using arms and services and for the using arms maintenance personnel. It is published in anticipation of the capture and use of the weapon described.

*b.* The manual consists of a translation and adaptation of the German Handbook D. (Luft) T. 1001, 2-cm Flakvierlinglafette,<sup>1</sup> and supplementary information from other sources.

<sup>1</sup>The term *Flak* is an abbreviation of "*Flieger- or Flugabwehrkanone*," which means "cannon for defense against aviation."

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c. In addition to a description of the 2-cm Flakvierling 38 (20-mm<sup>2</sup> antiaircraft gun, four-barreled mount), this manual contains technical information required for the identification, use, and care of the matériel.

d. Disassembly, assembly, and such repairs as may be handled by using arms personnel will be undertaken only under the supervision of an officer or the chief mechanic.

e. In all cases where the nature of the repair, modification, or adjustment is beyond the scope or facilities of the unit, the responsible ordnance service should be informed in order that trained personnel with suitable tools and equipment may be provided, or proper instructions issued.

f. The section on disassembly and assembly of the carriage contains information chiefly for the guidance of using arms maintenance personnel.

g. Instructions on description, functioning, and disassembly of the recoil mechanism, buffer mechanism, and 2-cm Flak 38 guns are either incomplete or entirely lacking. Firing tables are unavailable. The 2-cm Flak 38 gun is, however, a later model of the 2-cm Flak 30 gun (see fig. 45), which is described in section XII.<sup>3</sup> (A firing table for the 2-cm Flak 30 is given in par. 66a.)

**2. Characteristics.—a. General.—**(1) The 2-cm quadruple carriage is a mobile carriage for four 2-cm Flak 38 guns, which can be used to engage aircraft or land and sea targets.

(2) The 2-cm Flakvierling 38 is towed on a two-wheeled special trailer 52 (figs. 2, 3, 6, and 7).<sup>4</sup> The carriage can also be mounted on a special railway mount, on a turntable mount in half-track vehicles, or on a fixed support (figs. 1 and 5) in antiaircraft towers and coast defenses.

(3) For firing, the trailer is disengaged from the carriage, which then rests on the ground. In case of surprise attacks the gun may be fired from the trailer, but the extent of traverse in this position is only about 10° at top elevation.

<sup>2</sup> The German practice is to designate artillery calibers in terms of centimeters rather than millimeters.

<sup>3</sup> Like other German antiaircraft guns, the 2-cm guns may be called "dual-purpose" or "multipurpose" (or even "all-purpose") guns, since they are often employed in antitank and other roles. For a discussion of the matériel and technique of German antiaircraft artillery in general, see "German Antiaircraft Artillery," *MIS Special Series*, No. 10 (the 2-cm Flak 30 and the 2-cm Flak 38 are discussed in par. 7b).

<sup>4</sup> It should be noted that many of the illustrations accompanying this text are unavoidably based on photostatic copies of photographs. These copies are not always clear, and it may be difficult to identify particular parts or details on any one illustration. It is suggested that by comparison of different illustrations, it will often be possible to compensate for the defects of any one.



(4) The 2-cm Flakvierling 38 consists of a rotating ring rigidly connected to the lower carriage, with the upper carriage resting on the former and capable of being traversed 360°. The upper carriage

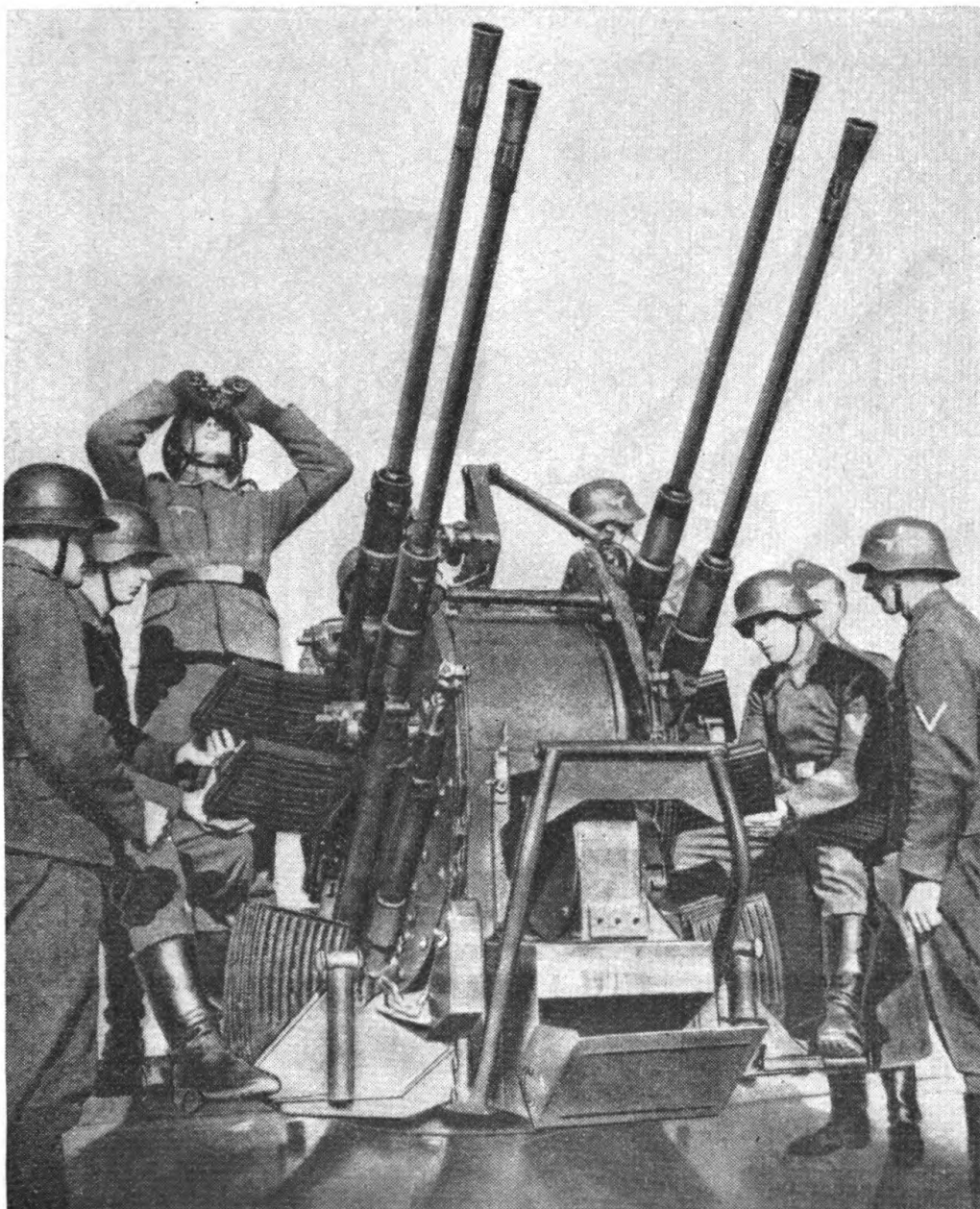
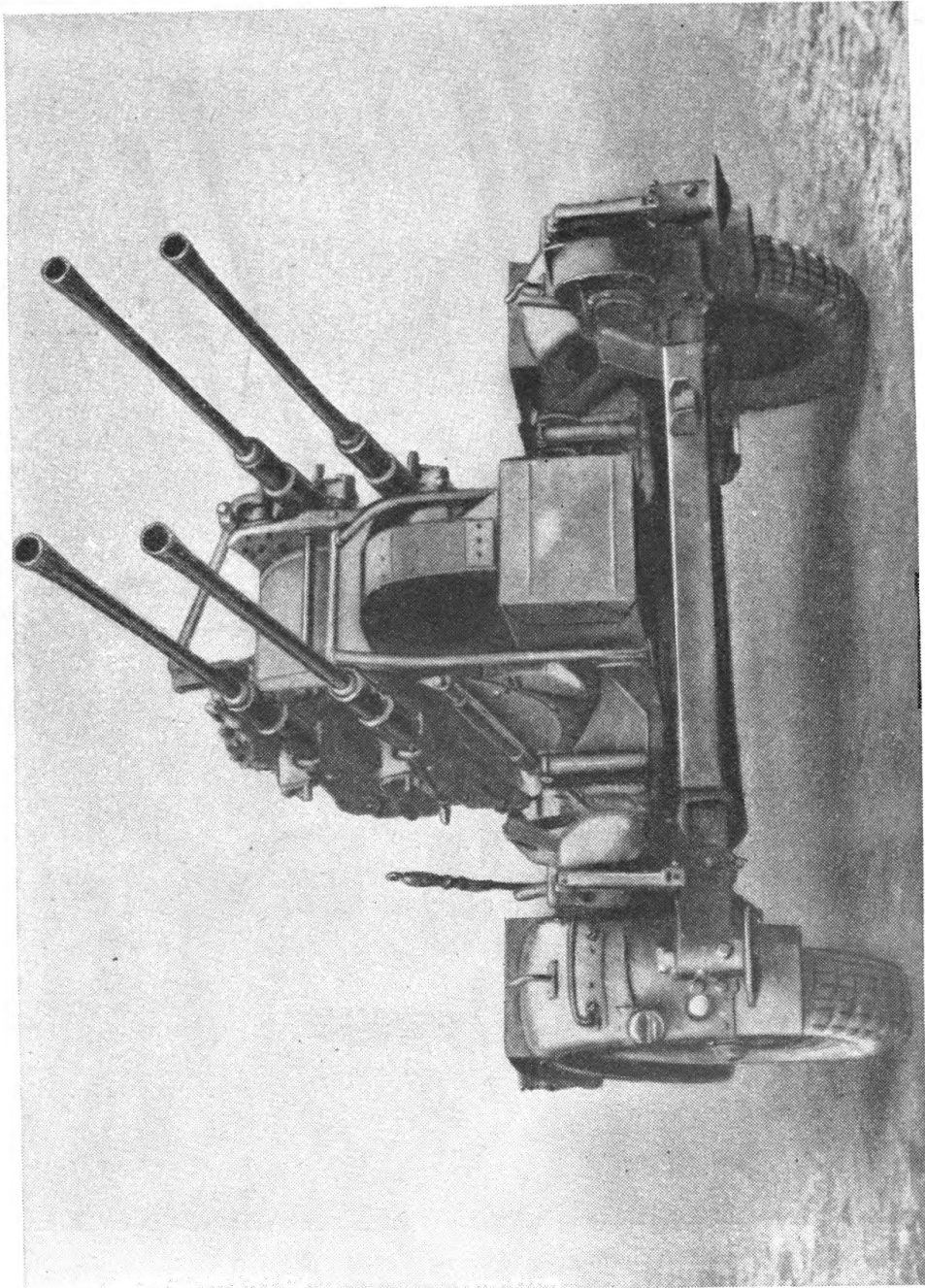


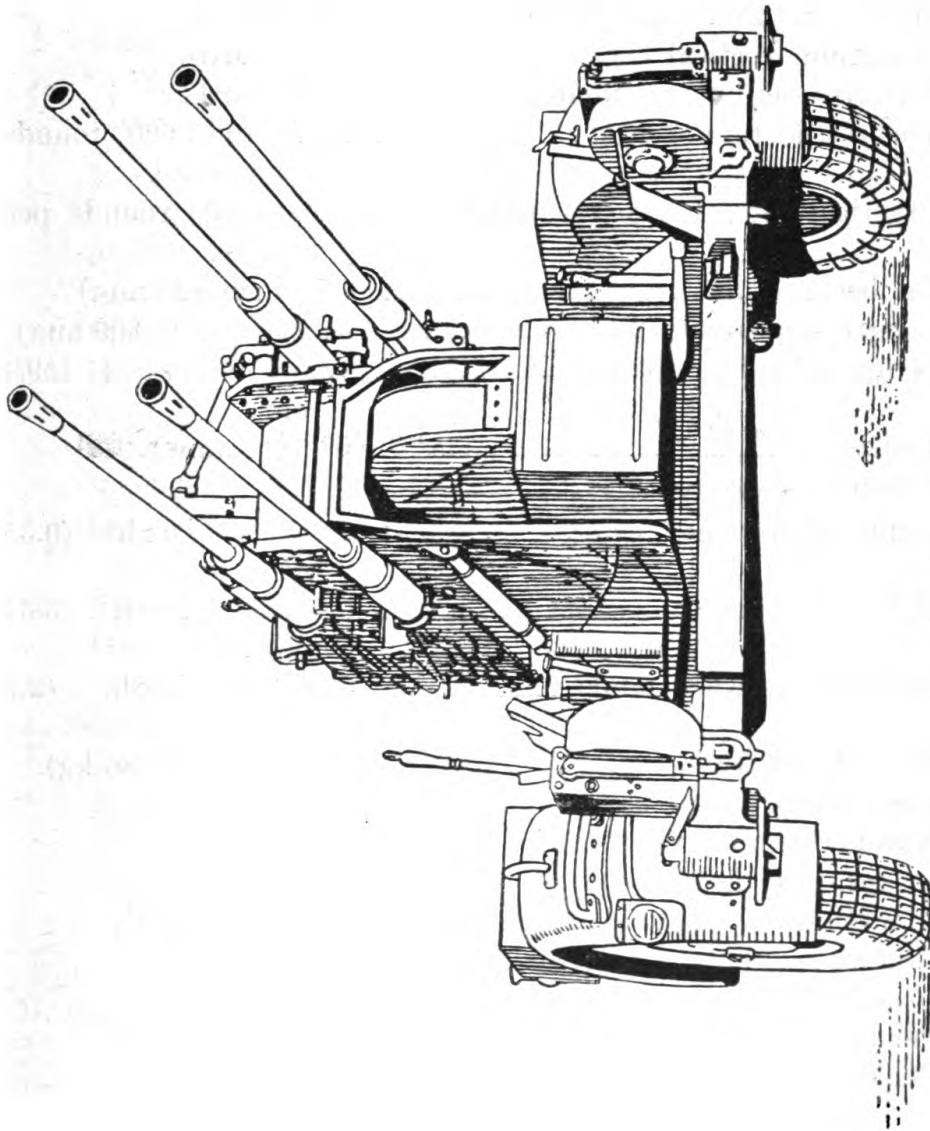
FIGURE 1.—2-cm Flakvierling 38 in firing position on fixed support.

carries the cradle, which can be elevated on it. These two parts (upper carriage and cradle) carry the firing mechanism, which is operated by pedals. The adjustable layer's seat is at the back of the upper carriage. In front of the seat are the elevating and traversing mechanisms and the sight bracket. The equilibrator and, below it,



① Photograph.

FIGURE 2.—2-cm Flakvierling 38 ready for transport on special trailer.



③ Drawing.

FIGURE 2.—2-cm Flakvierling 38 ready for transport on special trailer—Continued.

the deflector box are at the front of the upper carriage. On either side of the upper carriage are racks for the magazines.

*b. Gun.*

Muzzle velocity:

High-explosive.....	2,950 feet per second.
Armor-piercing.....	2,720 feet per second.
Maximum horizontal range.....	5,230 yards.
Maximum vertical range.....	4,155 yards.
Effective ceiling (estimated).....	2,405 yards.
Theoretical rate of fire.....	1,680 to 1,920 rounds per minute.
Practical rate of fire (estimated).....	700 to 800 rounds per minute.
Caliber.....	0.79 inch (20 mm).
Length of barrel (65 cal).....	51.2 inches (1,300 mm).
Length of rifling (59.97 cal).....	45.6 inches (1,159.4 mm).
Twist.....	5° (constant).
Number of grooves.....	8.
Depth of grooves.....	0.01378 inch (0.35 mm).
Width of grooves.....	0.21064 inch (5.35 mm).
Distance between lands.....	0.09843 inch (2.5 mm).
Weight of barrel.....	14 pounds (30.86 kg).
Capacity of magazine.....	20 rounds.
Number of magazines carried.....	16.

*c. Carriage.—(1) Laying.*

Elevation.....	−10° to +100°.
Traverse.....	360°.

*(2) Elevation.*

Per revolution of handwheel (fine)...	4°.
Per revolution of handwheel (coarse)...	12°.
Average power required to move handwheel (coarse setting)...	6.6 pounds.
Maximum power required to move handwheel (coarse setting)...	8.8 pounds.

*(3) Traverse.*

Per revolution of handwheel (fine)...	7½°.
Per revolution of handwheel (coarse)...	22½°.
Average power required to move handwheel (coarse setting)...	8.8 pounds.

Maximum power required to move 13.2 pounds.  
handwheel (coarse setting).

*d. Weights.*

2-cm four-barreled antiaircraft mount 1,766 pounds.  
38.

Four guns, each 123½ pounds..... 494 pounds.

2-cm four-barreled antiaircraft mount 2,260 pounds.  
38, with guns.

Lower carriage..... 719 pounds.

2-cm four-barreled antiaircraft mount 2,979 pounds.  
38, with guns, on lower carriage.

Sight head 38/40..... 15.8 pounds.

Linealvisier 21 (linear sight 21)..... 4.4 pounds.

Spare parts in trail box..... 15.4 pounds.

Sixteen full magazines (high-explosive) 331 pounds.

Gun in firing position on lower carriage 3,346 pounds.

Gun cover..... 37.4 pounds.

Special trailer 52..... 1,848 pounds.

Gun in traveling position with accessories and gun cover..... 4,866 pounds.

Fixed ring..... 198 pounds.

Gun in firing position on fixed ring with  
16 full magazines..... 2,798 pounds.

*e. Additional data.*

Force of recoil..... 2,205 pounds.

Recoil..... 3.346 inches (85 mm).

Initial run-out..... 0.6 inch (15 mm).

Height in fire position (figs. 3 and 4):

From the mount..... 3 feet 1 inch to 2 feet  
2 inches (940 to  
660 mm).

From the trailer..... 4 feet 10 inches to 3  
feet 11 inches (1,476  
to 1,196 mm).

Space requirements (figs. 4 and 5):

Diameter of the traverse circle:

At 0° elevation..... 11 feet 2 inches (3,420  
mm).

At 90° elevation..... 8 feet 6 inches (2,610  
mm).

On special trailer 52, ready for transport (fig. 3):

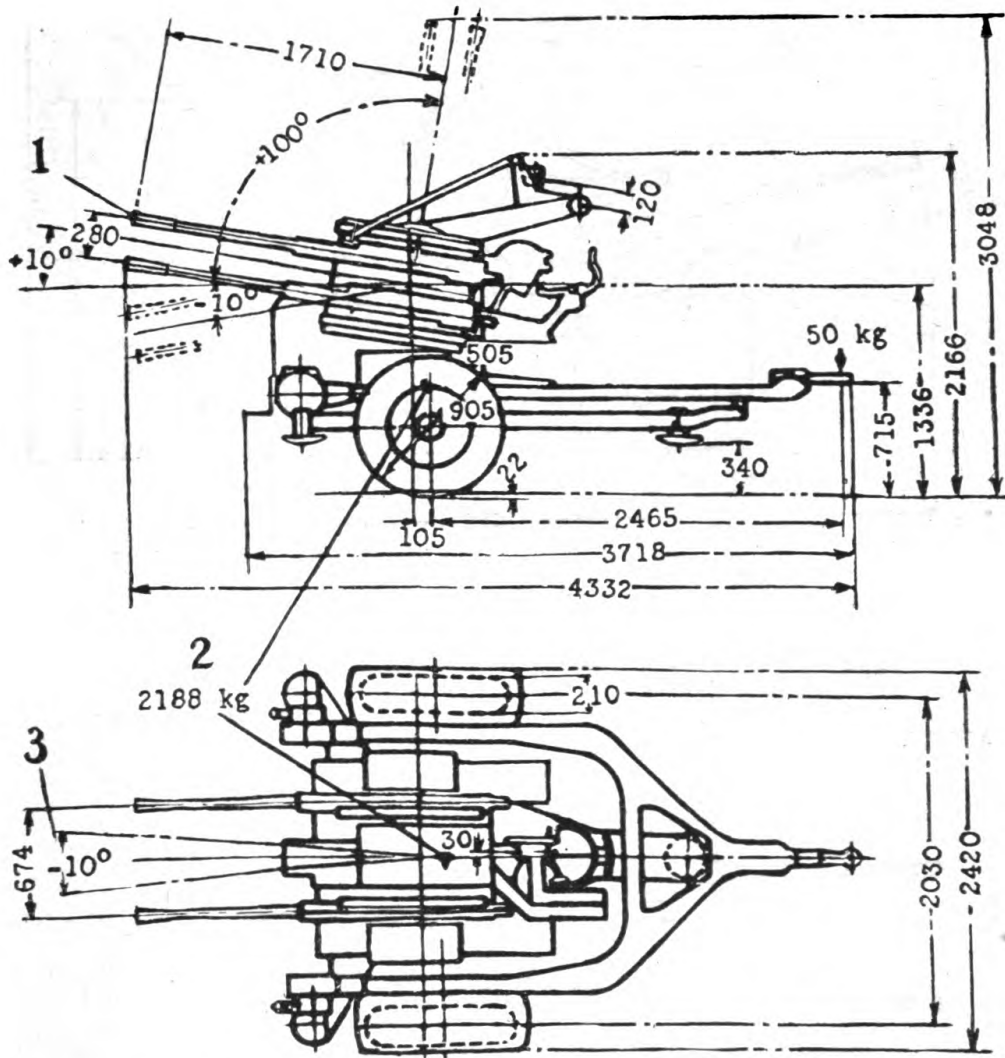
Length.....	14 feet 2 inches (4,332 mm).
Breadth.....	7 feet 11 inches (2,420 mm).
Height (to top of control rod) ..	7 feet 1 inch (2,169 mm).
Height (to muzzle at 100° elevation).....	10 feet (3,048 mm).

On triangular carriage (locked position, fig. 4):

Length.....	12 feet (3,684 mm).
Breadth.....	7 feet 8 inches (2,336 mm).
Height (to top of control rod) ..	6 feet (1,826 mm).
Height (to muzzle at 100° elevation).....	8 feet 11 inches (2,708 mm).

On fixed support (fig. 5):

Maximum length (locked position).....	9 feet 10 inches (3,014 mm).
Breadth.....	7 feet 8 inches (2,336 mm).
Height (to top of control rod) ..	5 feet 10 inches (1,765 mm).
Height (to muzzle at 100° elevation).....	8 feet 7 inches (2,627 mm).

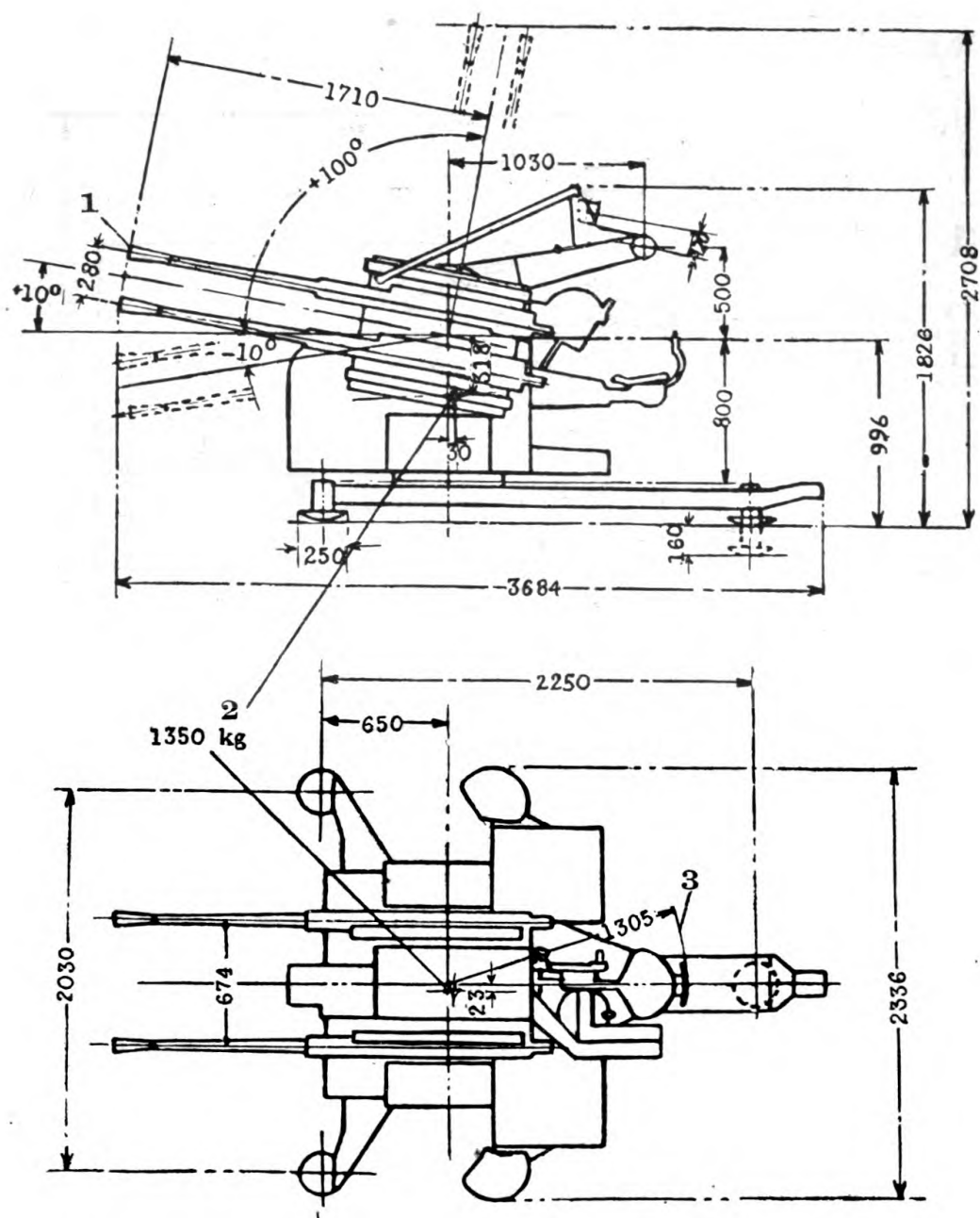


1. Zurrstellung (locked position).  
 2. Schwerpunkt (center of gravity).

3. Seitenrichtbereich (extent of traverse).

FIGURE 3.—2-cm Flakvierling 38 on special trailer 52—sketch of space requirements (with linear measurements in mm).





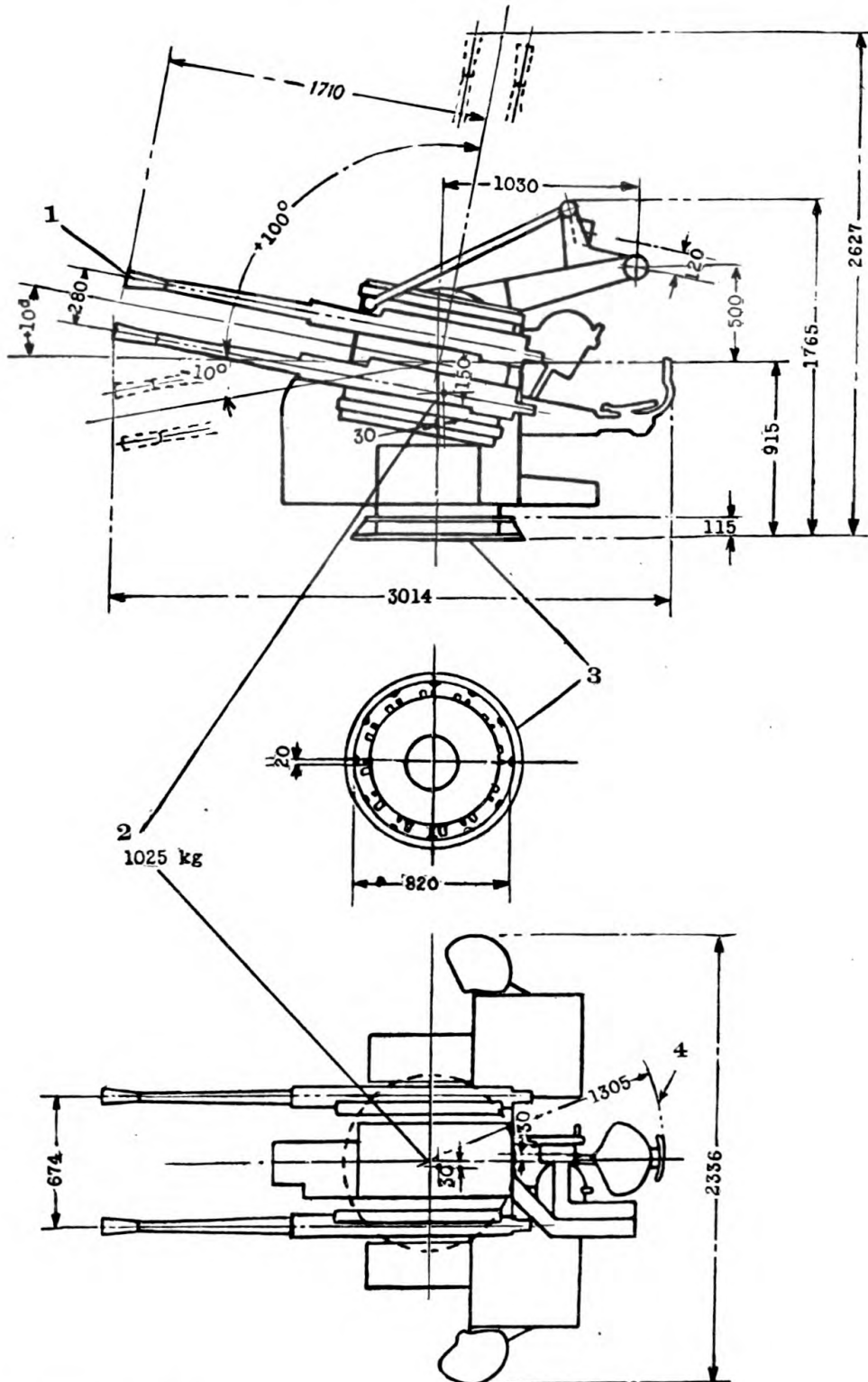
1. Zurrstellung (locked position).

3. Störkreis (traverse arc).

2. Schwerpunkt (center of gravity).

FIGURE 4.—2-cm Flakvierling 38 in position on triangular carriage—sketch of space requirements (with linear measurements in mm).

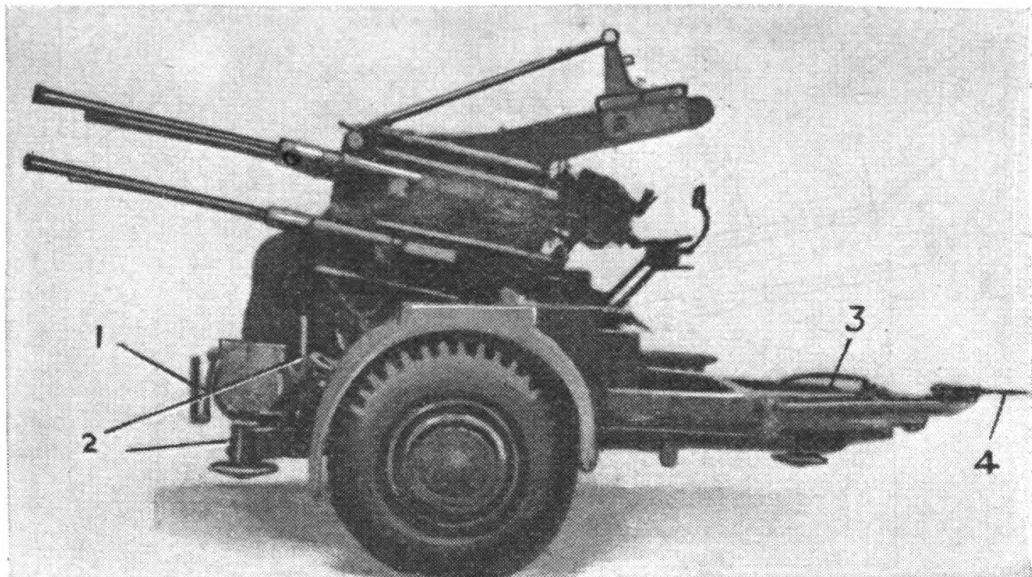




1. Zurrstellung (locked position).  
 2. Schwerpunkt (center of gravity).

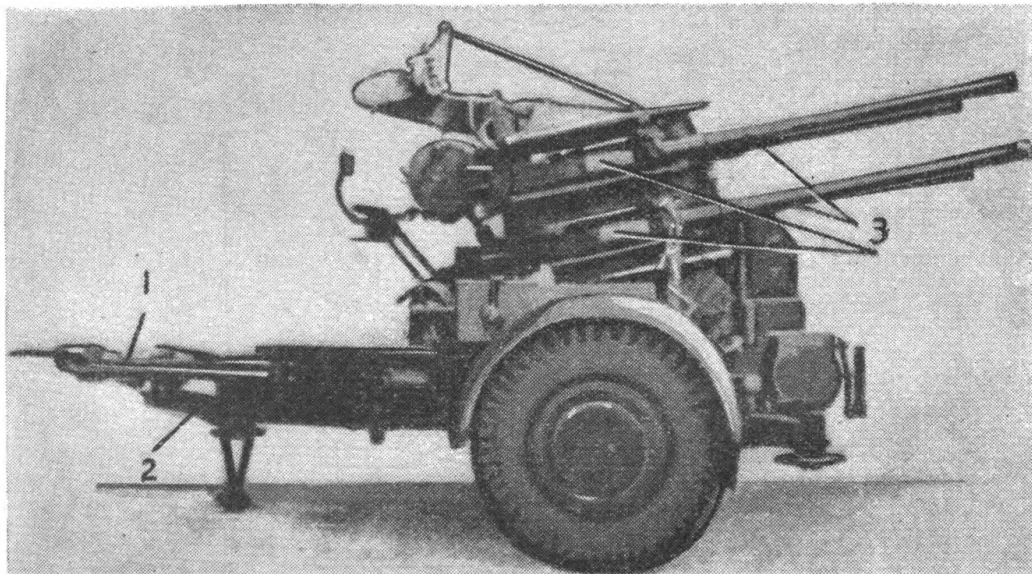
3. Aufnahmering (receiving ring).  
 4. Störkreis (traverse arc).

FIGURE 5.—2-cm Flakvierling 38 on stationary receiving ring—sketch of space requirements (with linear measurements in mm).



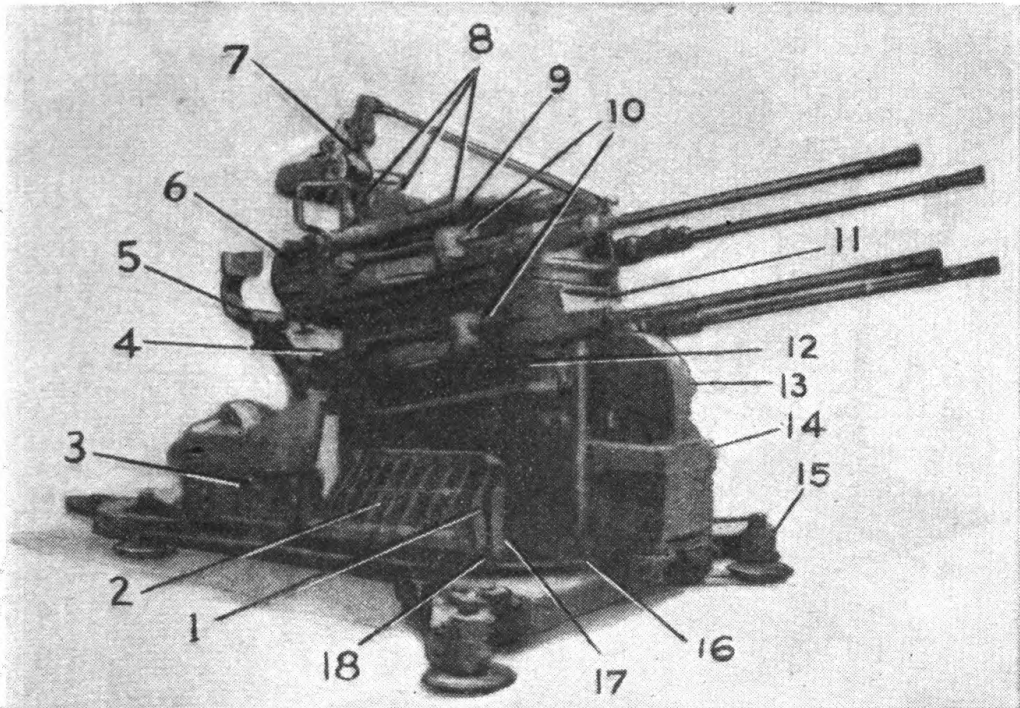
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|---|--------------------------------|
| 1. Kurbel der Kettenwinde (crank of chain winch). | 3. Sperrhebel (locking lever). |
| 2. Griff zum Zurrhaken (handle of locking hook).  | 4. Protöse (lunette).          |

FIGURE 6.—2-cm Flakvierling 38 in traveling position without gun cover—left side view.



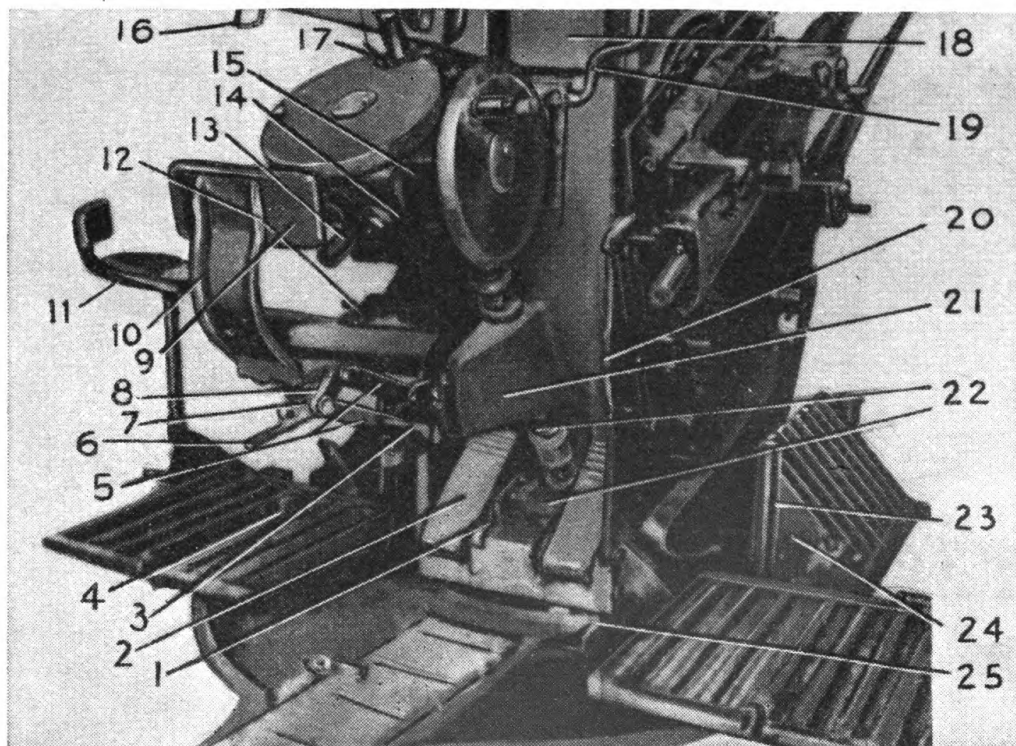
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|--|---|
| 1. Sonderanhänger 52 (special trailer 52). | 3. Waffen mit eingesetzten Staubdeckein (guns with dust covers on). |
| 2. Lafettendreieck (triangular base).      |   |

FIGURE 7.—2-cm Flakvierling 38 unlimbered—right side view.



- |   |   |
|---|---|
| 1. Fussstütze hochgeklappt (footrest folded upward).                                  | 9. Rücklafeinrichtung (recoil mechanism),   |
| 2. Magazinlager (magazine rack).  | 10. Schlitten (sleighs).  |
| 3. Plattform, scharvierartig angelenkt (platform, connected up hinge-like).           | 11. Zurrung, eingelegt (locking mechanism, in place).   |
| 4. Abzugsschiene der Abzugsvorrichtung (trigger bar of firing mechanism).             | 12. Deckel der Wiege (cover of cradle).   |
| 5. Richtsitz in der obersten Raststellung (layer's seat in highest rest position).    | 13. Ausgleicher (equilibrator).   |
| 6. Handrad für Höhenrichtmaschine (handwheel for elevating mechanism).                | 14. Hülsenkasten mit geschlossener Klappe (deflector box with lid closed).                                |
| 7. Visierträger (sight bracket).  | 15. Lafettendreieck (triangular base).  |
| 8. Anschluss zum Befestigen des Visierschildes (coupling for fastening sight shield). | 16. Oberlafette (upper carriage).   |
|   | 17. Anschluss zum Befestigen des rechten Schutzschildes (coupling for fastening right protecting shield). |
|   | 18. Plattformhälfte angeschraubt (platform half, screwed on).   |

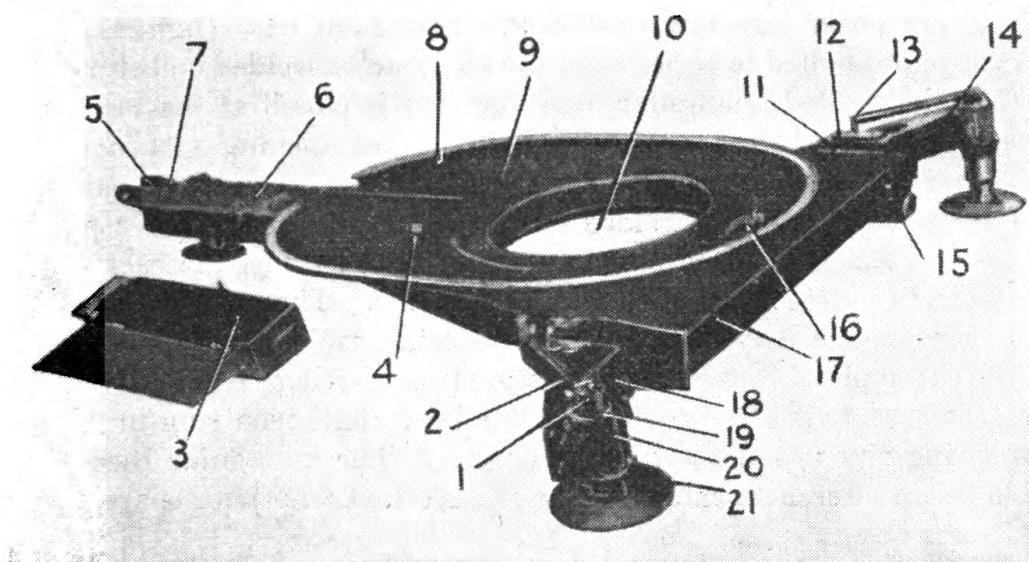
FIGURE 8.—2-cm Flakvierling 38 in position—right side view.



- |   |  |
|---|--|
| 1. Abdeck blech (removable cover plate).                            | 15. Höhenrichtmaschine (elevating mechanism).  |
| 2. Fusshebel (pedal).   | 16. Halteöse (holding eye).  |
| 3. Rastgriff (stop handle).   | 17. Handfalle (hand catch).  |
| 4. Plattform (platform).  | 18. Batteriekasten (battery box).  |
| 5. Schwenkarme (bracket arms.)                                      | 19. Haltegriff (stop handle).  |
| 6. Hebel (lever)  | 20. Abweiser (guard).  |
| 7. Führung (sleeve).  | 21. Sitzarm (seat rest).   |
| 8. Anschlag (lug).  | 22. Gelenkwelle und Gehäuse des Seiten-<br>triebes (drive shaft and traversing<br>gear housing). |
| 9. Rückenblech (back rest plate).                                   | 23. Aufnahme für Winkelstock (tube for<br>bent rod).   |
| 10. Rückenlehne (back rest).  | 24. Magazinlager (magazine rack).  |
| 11. Ladesitz (loader's seat).                                       | 25. Zurrmarken (locking marks).  |
| 12. Richtsitz (layer's seat).                                       |  |
| 13. Handgriff für Klemmvorrichtung (han-<br>dle for clamping gear). |  |
| 14. Seitenrichtmaschine (traversing mecha-<br>nism).                |  |

FIGURE 9.—2-cm Flakvierling 38—right rear view.





- |   |  |
|---|--|
| 1. Tragzapfen (carrier pin).              | 13. Raste (notch).   |
| 2. Horizontierungsriff (leveling handle). | 14. Träger (carrier).  |
| 3. Lafettenkasten (trail box).            | 15. Dosenlibelle (spirit level).                                 |
| 4. Winkel (angle).                        | 16. Böckchen (support).  |
| 5. Tragzapfen (carrier pin).              | 17. Dreiecksverband (triangular structure).                      |
| 6. Führungzapfen (guide pin).             | 18. Aufhängehaken (suspension hooks).                            |
| 7. Anfahrmearm (receiving arm).           | 19. Sperrbügel (locking stirrup).                                |
| 8. Winkelring (angle ring).               | 20. Gehäuse für Horizontierungsspindel (leveling shaft housing). |
| 9. Deckblech (cover plate).               | 21. Horizontierungsvorrichtung (leveling device).                |
| 10. Aufnahmeöffnung (opening).            |  |
| 11. Rahmen (frame).                       |  |
| 12. Gummiplatte (rubber pad).             |  |

FIGURE 10.—Lower carriage of 2-cm Flakvierling 38.

## SECTION II

## DESCRIPTION AND FUNCTIONING

	Paragraph
Lower carriage-----	3
Upper carriage and rotating ring-----	4
Sight bracket-----	5
Elevating mechanism-----	6
Traversing mechanism-----	7
Electric generators-----	8
Layr's seat-----	9
Firing mechanism-----	10
Equilibrator-----	11
Deflector box-----	12
Platform-----	13
Magazine rack-----	14
Locking mechanism-----	15
Cradle-----	16
Sleighs-----	17

**3. Lower carriage** (figs. 6 to 12, incl., 14, and 15).—*a.* The lower carriage (*Lafettendreieck*) supports the upper carriage (*Oberlafette*)

and makes the weapon mobile on special trailer (*Sonderanhänger*) 52.

(1) The lower carriage consists of a triangular base (fig. 10), two carrier plates bolted to either side, and the bracket welded on behind.

(2) The welded triangular base (fig. 10) is closed at the top by a cover plate (*Deckblech*). In the middle is an opening (*Aufnahmeöffnung*) for the ring pivot. An angle ring (*Winkelring*),<sup>5</sup> painted red for identification, is welded on the right side of the cover plate. When the gun is in place, this angle ring rests against the back edge of the right outside wall of the upper carriage. The positioning gear can then engage between the small pedestals welded onto the front of the cover plate, thus preventing the upper carriage from swiveling. The cover plate is also provided with a bent angle iron ring in which the spring rings of the gun cover engage. The triangular base also includes an interchangeable trail box (*Lafettenkasten*) for spare parts and accessories.

(3) The circular spirit level (*Dosenlibelle*) (figs. 10 and 15), mounted on the fore part of the triangular base, insures that the lower carriage and the upper carriage are correctly leveled. The level is protected by a hinged cover.

b. Brackets are bolted to the right and left sides of the triangular base. To these are secured the eyes into which the locking hooks (*Zurrhaken*) of the trailer engage. The eyes act as suspension hooks (*Aufhängenhaken*) for the winch chains (figs. 6 and 10). These suspension hooks are fitted with pivoting locking clips to prevent the winch chains from loosening. The rubber pads (*Gummiplatten*) mounted on the carriers (*Träger*) are used mainly to support the upper carriage against the lower carriage, but they also absorb a certain amount of bumping during transport.

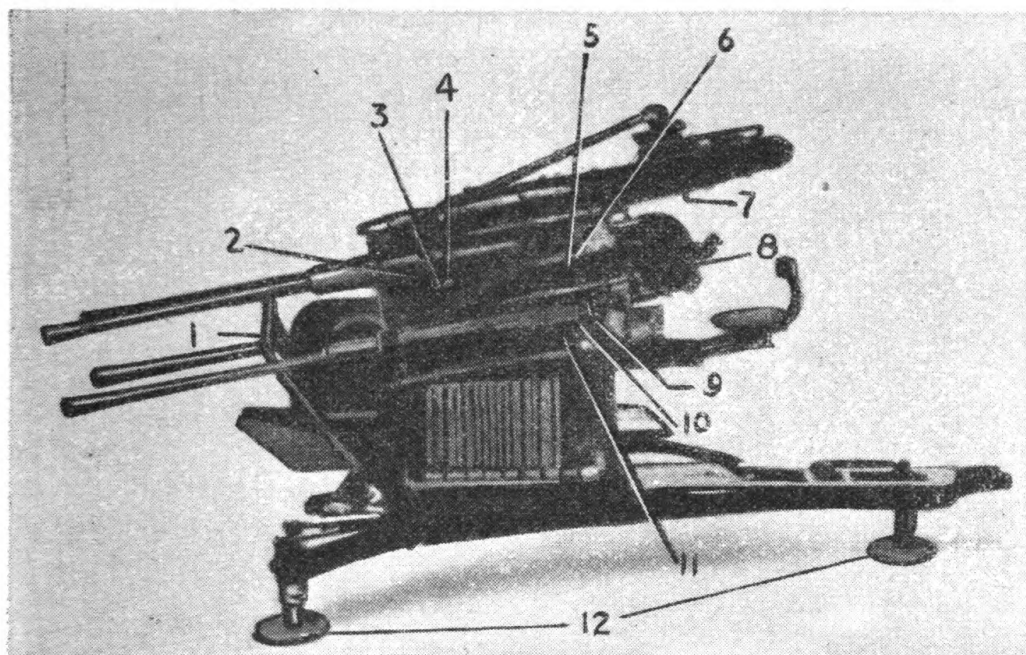
c. (1) On the outside ends of the carriers (*Träger*) are bolted housings for the leveling screws which are used to level the carriage. The leveling handles (*Horizontierungsgriffe*) are placed in the recesses in the triangular base when the weapon is not in use.

(2) A third leveling screw is at the back of the triangular base. In front of the screw is a guide pin (*Führungszapfen*) which, when the locking mechanism (*Zurrun*) is in action, engages in the corresponding guide on the trailer, thus locking the triangular base longitudinally in relation to the trailer. Behind this leveling screw, the carrier pin (*Tragzapfen*) fits in the carrier bracket and engages in the corresponding hook on the trailer.

<sup>5</sup> In the quadruple antiaircraft mounts recently manufactured, this angle ring is replaced by an indicator hoop, painted red and bolted to the cover plate of the triangular base. A pointer bolted to the rear bracket of the right half of the platform (fig. 9) points to this indicator stirrup when the ring pivot is in position. (Figs. 9 and 10, therefore, do not represent current practice.)

d. (1) The guide pin is secured by four hexagonal bolts and nuts provided with lock washers. The carrier pin, behind the guide pin, is secured in the carrier bracket by means of a castle nut which is secured by a cotter (*Splint*) pin.

(2) The other carrier pins are secured to the carriers by counter-



- |   |  |
|---|--|
| 1. Abweiser (guard).                    | 8. Deckel (cover).                         |
| 2. Kurbelarm (crank arm).               | 9. Umstellhebel (reversing lever).         |
| 3. Riegelbolzen (catch bolts).          | 10. Waffengehäuse (gun housing).           |
| 4. Haltebolzen (locking bolts).         | 11. Unterbrecherhebel (interrupter lever). |
| 5. Bodenstückbolzen (breechlock bolts). | 12. Horizontierungsvorrichtung ganz ausge- |
| 6. Sperre (lock).                       | schraubt (leveling device entirely un-     |
| 7. Halteöse (holding eye).              | screwed).                                  |

FIGURE 11.—2-cm Flakvierling 38 at about 10° depression—left side view.

sunk bolts, castle nuts, and cotter pins. The rubber pads are fitted in frames (*Rahmen*) each of which is secured by five bolts with adapter plates underneath.

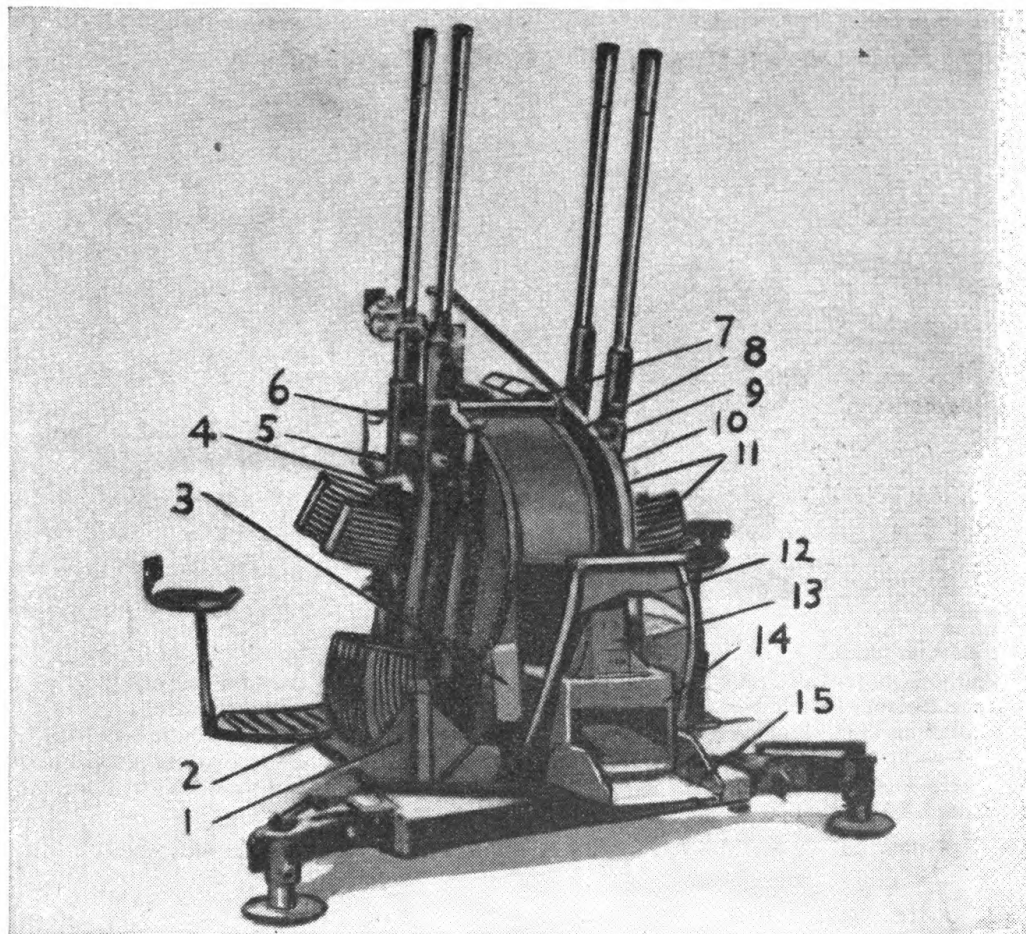
(3) The bracket for spirit level adjustment is secured in position by two pins and two bolts.

4. **Upper carriage and rotating ring** (figs. 8, 9, 12, 13, 19, and 20).—a. (1) The upper carriage (*Oberlafette*) carries the cradle, the battery for lighting the sight,<sup>6</sup> the sight bracket, the elevating and traversing mechanisms, the layer's seat, the equilibrator, the deflector box, the two platforms with their magazine racks, and part of the firing mechanism.

<sup>6</sup> The battery box (*Batteriekasten*) contains an accumulator, type 4 S. NC 10.

(2) The upper carriage, together with the trunnions, is mounted on the ball bearing of the rotating ring, and can be traversed through  $360^\circ$ . The ball bearing insures easy traverse.

b. The rotating ring (*Drehring*) is secured to the lower carriage by 12 clamping pieces and carries an azimuth scale (*Seitenteilring*) which is graduated into 6,400 mils ( $360^\circ$ ).



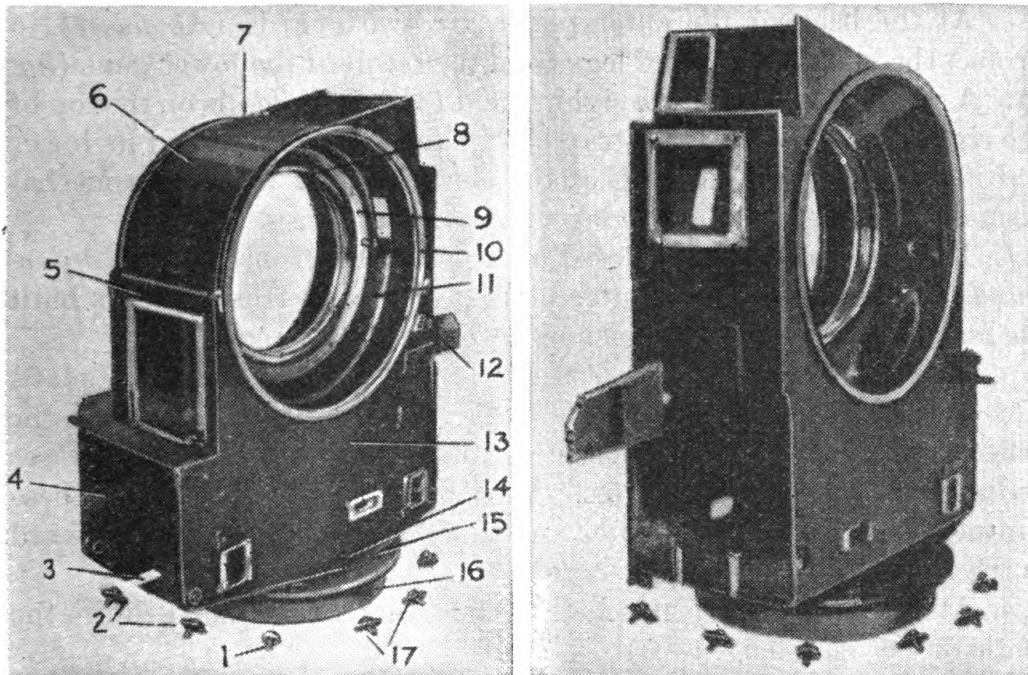
- |   |   |
|---|---|
| 1. Magazinlager (magazine rack).          | 9. Seilzug 1 (cable-pulley unit 1).         |
| 2. Plattform (platform).                  | 10. Seilzug 4 (cable-pulley unit 4).        |
| 3. Schutzkasten (protecting box).         | 11. Seilrollen (cable pulleys).             |
| 4. Seilrollenträger (cable-drum bracket). | 12. Abweiser (guard).                       |
| 5. Seilzug 3 (cable-pulley unit 3).       | 13. Ausgleicher (equilibrator).             |
| 6. Seilzug 2 (cable-pulley unit 2).       | 14. Hülsenkasten mit ganz geöffneter Klappe |
| 7. Deckel der Wiege (cover of cradle).    | (deflector box with lid wide open).         |
| 8. Kugelhälter (thrust collar).           | 15. Klappe (lid).                           |

FIGURE 12.—2-cm Flakvierling 38 at about  $75^\circ$  elevation—right front side view.

c. On the base plate (*Grundplatte*), welded to the rotating ring, is the attachment for the traversing mechanism. On the right edge of the base plate is a white panel with a black pointer which acts as an index for the azimuth scale.



d. The upper carriage has two internal vertical webs housing the ball bearing (*Kugellager*) in which the cradle trunnions revolve. The locking mechanism (*Zurrung*) is pivotally supported on the front bottom part of the outer plates (*Ausserwände*). Behind it are the brackets for securing the platforms. Between the front and rear plat-



① Front, left.

② Right, below.

1. Sechskanteschraube (hexagonal screw).
2. Klemmstücke (clamping pieces).
3. Ausschnitt für die Zunge der Zurrung (cutaway for tongue of locking mechanism).
4. Rutschblech (slide plate).
5. Vorderwand (front plate).
6. Haube (hood).
7. Anschlag (stop).
8. Kugellager (ball bearing).
9. Druckring (pressure ring).
10. Schutzring (protecting ring).
11. Innerwand (inner plate).
12. Sitzarm (seat rest).
13. Ausserwand (outer plate).
14. Grundplatte (base plate).
15. Seitenteilring (azimuth scale).
16. Drehring (rotating ring).
17. Sicherungsbleche (safety plates).

FIGURE 13.—Upper carriage with rotating ring.

form brackets are bearings for the intermediate shafts (*Zwischenwellen*) of the firing mechanism (*Abzugsvorrichtung*). Between the platform brackets and outside the outer plates are the firing rods (*Abzugswellen*), carried by bearings bolted externally to the upper

carriage. On the lower part of the outer plates are bolts for securing the boxes (*Schutzkasten*) which protect the levers and pull rods (*Zugstangen*) of the firing mechanism. The rear edge of the right outer plate has a mark painted underneath, and the equipment is correctly assembled when this mark is coincident with the mark painted on the top of the angle ring in the triangular base.

e. At the back of the outer plates are two guards (*Abweiser*) to protect the layer's knees and legs from the recoil of the lower guns (fig. 9). A securing strap for the sight shield (*Visierschild*) is on the top of the right outer plate. This strap has a handle fixed to it, and its lower end is secured to the housing of the elevating and traversing mechanisms. The handle helps the layer in and out of his seat.

f. The upper carriage is closed in front by the front plate (*Vorderwand*) connecting the two outer plates. Into this front plate is built the hood (*Haube*), which continues into the rear plate.

g. The equilibrator (*Ausgleicher*) is attached to the front plate. The opening in the front plate below the equilibrator is closed by the deflector box (*Hülsenkasten*), which catches the empty cartridge cases sliding over the runway plates. Starting from the rear plate, these runways pass between the outer and inner plates obliquely downward to the front plate.

h. A stop (*Anschlag*) attached to the flange of the hood limits the angle of elevation (fig. 13①).

i. The battery which supplies the current for lighting the sight is bolted on the top right of the rear plate. The back of the battery box is marked 1 L and 2 R, and, below, 4 L and 3 R, to indicate to the gunner the order of firing. On the left of the battery the sight bracket is bolted to the rear plate; below it is the housing for the elevating and traversing mechanisms.

j. The contracted portion of the rear plate has the seat brackets in the middle. Below this, on the removable cover plates (*Abdeckbleche*) for protecting the firing mechanism, are the pedals (*Fusshebel*) which operate the firing mechanism. The gap<sup>7</sup> between these cover plates is closed by a cover.

k. The rotating ring can be fitted on any support on which the 3.7-cm Flak 36 gun can be mounted (see fig. 50).<sup>8</sup>

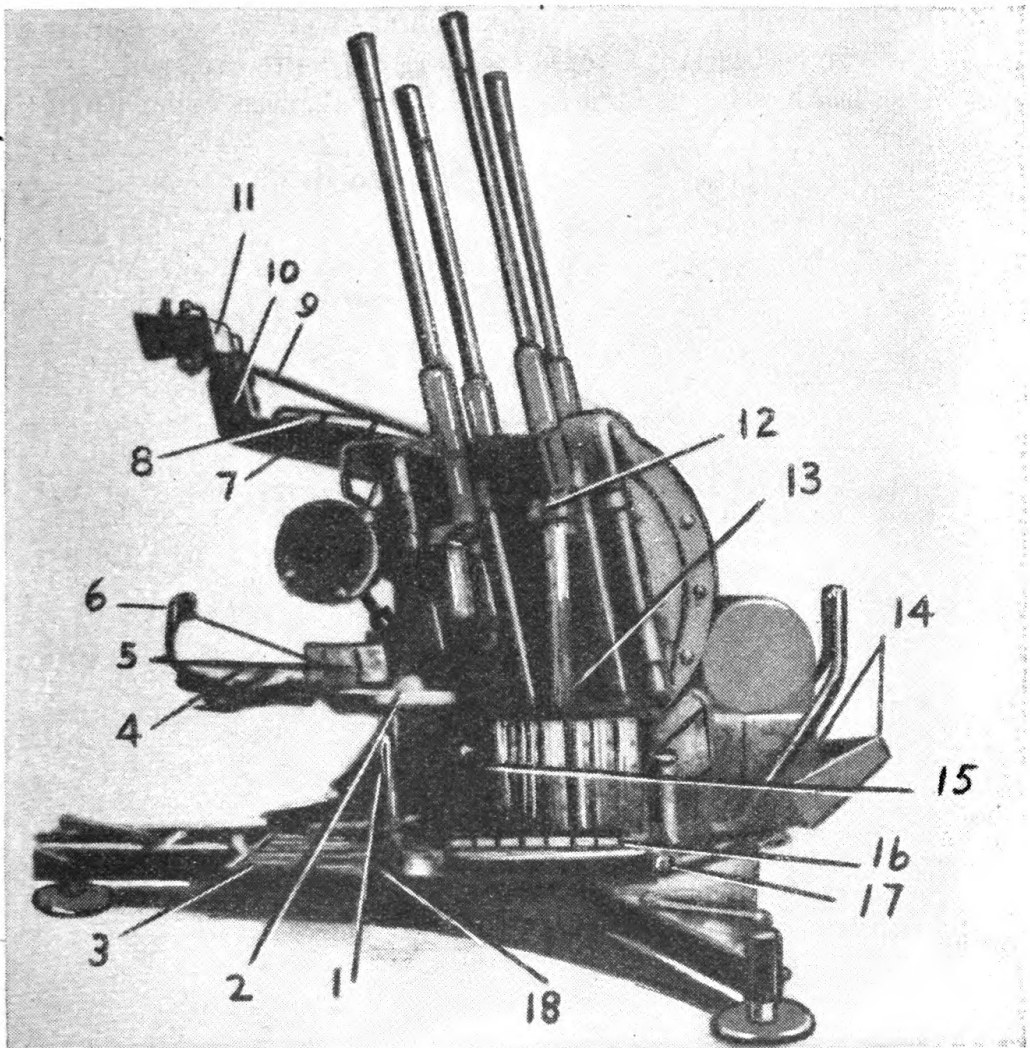
l. (1) The clamping pieces (*Klemmstücke*) are bolted to the lower carriage.

(2) In the support housing of the rotating ring, the ball bearing is held in position by the rack which is bolted to the flange of the bearing housing.

<sup>7</sup> This gap is provided so that a traversing stop may be fitted later.

<sup>8</sup> For details on the 3.7-cm Flak 36, see "German Antiaircraft Artillery," *MIS Special Series*, No. 10, par. 7d.

(3) A special packing fitted to the outside of the rack prevents dust and dirt from getting between the rotating ring and upper carriage.



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|--|--|
| 1. Griff im Sitzbein (handle on seat leg). | 12. Kurbelarm (crank arm).   |
| 2. Ladesitz (loader's seat).               | 13. Sperre (lock).   |
| 3. Holzleisten (wooden strips).            | 14. Hülsenkasten mit halb geöffneter Klappe<br>(deflector box with lid half open). |
| 4. Richsitz (layer's seat).                | 15. Aufnahme für Winkelstock (tube for<br>bent rod).                               |
| 5. Rückenlehne (back rest).                | 16. Holzfutter (wooden shelves).   |
| 6. Rückenblech (back rest plate).          | 17. Fussstütze (footrest).   |
| 7. Träger (bracket).                       | 18. Zahnbogen des Sitzlagers (elevating rack<br>of seat support).                  |
| 8. Haltegriff (stop handle).               |  |
| 9. Steuerstange (distributing rod).        |  |
| 10. Schwenkarm (bracket arm).              |  |
| 11. Visierkopf 38/40 (sight head 38/40).   |  |

FIGURE 14.—2-cm Flakvierling 38 at about 100° elevation—right side view.

(4) The wheel-shaped pivot has a lock ring bolted to it to prevent its lifting in the inner race of the ball bearings.

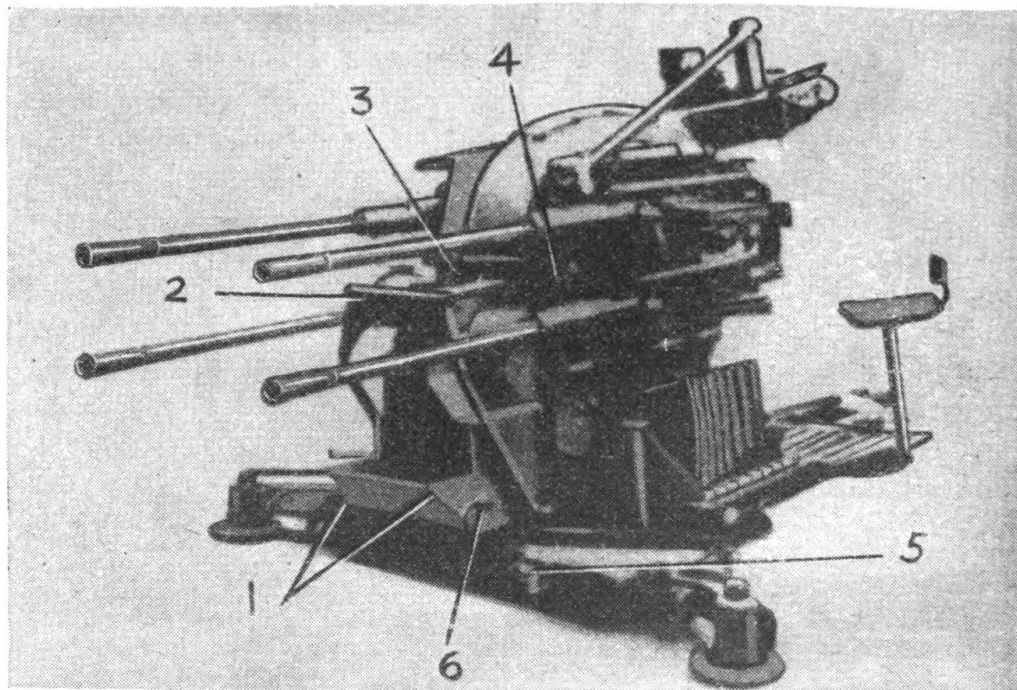
(5) The upper carriage is of built-up construction to facilitate manufacture.

(6) A packing consisting of two interlocking rings is fitted between the cradle and the upper carriage to keep out dirt and dust. One ring is secured to the outer plates at the edge of the large round opening; the other, to the cradle between the drums and covers.

(7) The protecting rings (*Schutzringe*) are bolted together.

(8) The ball bearing is held in position by a thrust collar (*Kugelhälter*).

(9) The stop is bolted to the flange of the hood.



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| 1. Hülsenkasten mit halb geöffneter Klappe (deflector box with lid half open). | 3. Zurrbolzen (locking pins).            |
| 2. Oberes Querrohr der Zurrung (upper cross tube of locking mechanism).        | 4. Rasthebel (safety catch).             |
|  | 5. Dosenlibelle (circular spirit level). |
|  | 6. Flügelmutter (wing nut).              |

FIGURE 15.—2-cm Flakvierling 38 at 0° elevation—left side view.

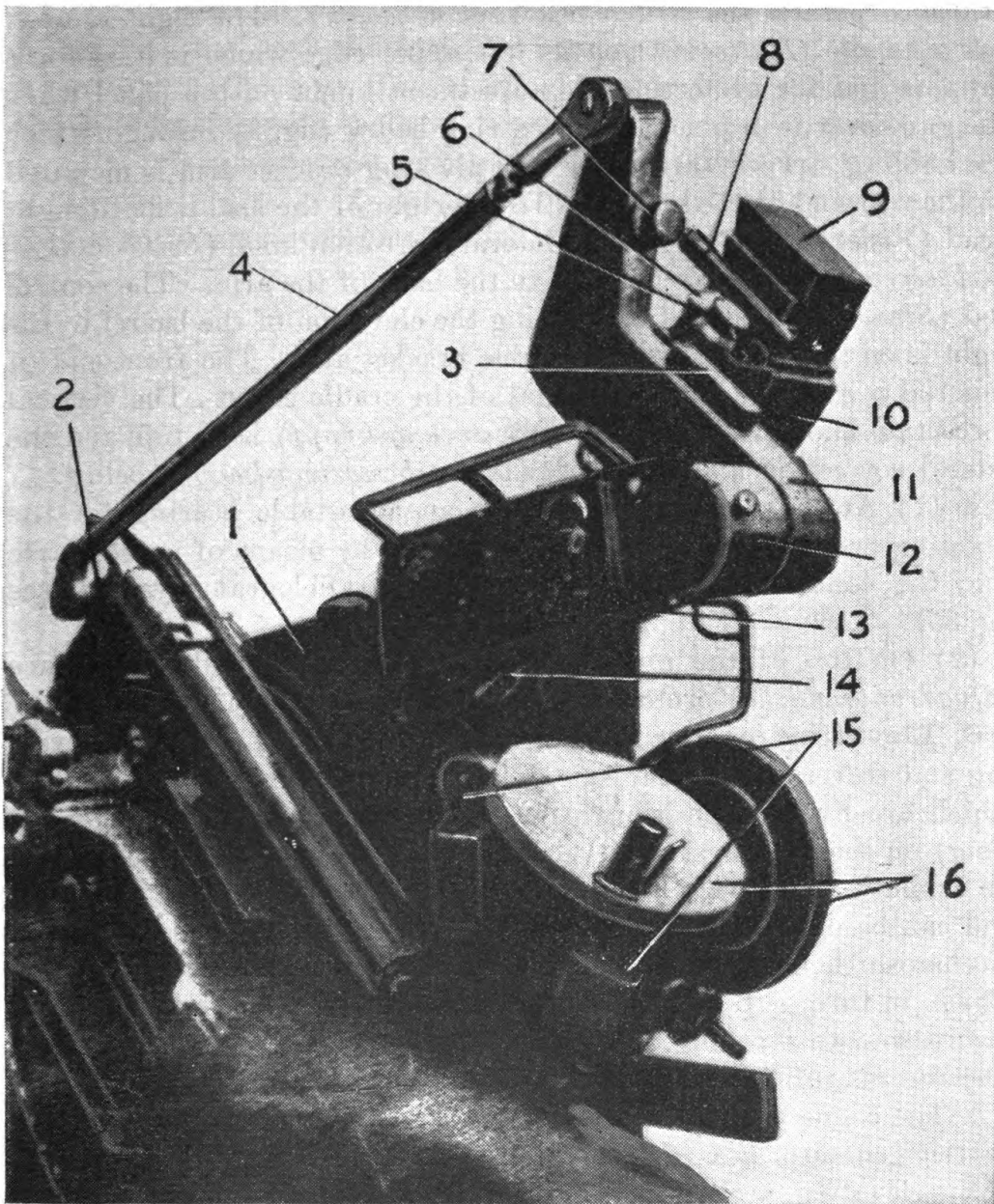
(10) The firing pedals are both pivoted on a pin in the stirrups of the cover plates.

(11) Arrangements for fitting the sight shield are provided on the upper part of the upper carriage.

**5. Sight bracket** (figs. 8, 9, 14, and 16).—*a*. The sight bracket (*Visierträger*) takes Flakvisier 38/40 (antiaircraft sight 38/40).<sup>9</sup> It comprises the bracket (*Träger*) and the pivoting bracket arm (*Schwenkarm*).

<sup>9</sup> Linealvisier 21 (linear sight 21), with separate pivoting arm, may also be used. (See par. 42 and sec. VIII.)





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|--|--|
| 1. Anschlussgetriebe (connecting gear).                                    | 8. Zielfernrohr (telescopic sight).                      |
| 2. Lagerbock (coupling recess).  | 9. Regenschutzkappe (cover for protection against rain). |
| 3. Schutzkappe der Quadrantenfläche (protecting cap for quadrant surface). | 10. Visierkopf 38/40 (sight head 38/40).                 |
| 4. Steuerstange (distributing rod).  | 11. Schwenkarm (bracket arm).                            |
| 5. Seitenwinkelverbesserungsknopf (lateral correction knob).               | 12. Träger (bracket).                                    |
| 6. Druckschraube (pressure screw).   | 13. Schaltkasten (switch box).                           |
| 7. Höhenwinkelverbesserungsknopf (vertical correction knob).               | 14. Batteriekasten (battery box).                        |
|  | 15. Tachokasten (electric generator boxes).              |
|  | 16. Handräder (handwheels).                              |

FIGURE 16.—Sight bracket with Flakvisier 40 (antiaircraft sight 40).

b. The bracket is bolted to the rear plate of the upper carriage. It also incorporates the switch box (*Schaltkasten*). The sight bracket has a handle (*Haltegriff*) on its left upper edge which is used for a support and for protecting the adjustment knobs on the panel when the gun cover is in place. It has a ring below (fig. 9) through which the holding strap is threaded. The pivoting bracket arm is mounted on the rear end of the bracket. To the right of the arm is fitted sight head (*Visierkopf*) 38/40. The lateral correction knob (*Seitenwinkelverbesserungsknopf*) is attached to the back of the arm. The control rod (*Steuerstange*) for transmitting the elevation of the barrel to the sight is on the front of the pivotable bracket arm. The front end of this rod is attached to the pedestal of the cradle cover. The vertical correction knob (*Höhenwinkelverbesserungsknopf*) is on top, and the lateral correction knob (*Seitenwinkelverbesserungsknopf*) below.

c. (1) At the rear of the sight is an adjustable bearing for the pivoting bracket arm, to which is attached, by means of an eccentric pin, the control rod for adjusting the parallelogram system (see fig. 35).

(2) On top of the pivoting bracket arm is a quadrant surface (*Quadrantenfläche*) protected by a cap (*Schutzkappe*).

6. Elevating mechanism (figs. 9, 16, 17, and 18).—a. The elevating and traversing mechanisms (*Höhen- und Seitenrichtmaschinen*), which are fixed in position by the clamping gear (*Klemmvorrichtung*) on the housings, are used for laying the guns in elevation and in azimuth. Both are fitted in dustproof and dirtproof housings and can be operated simultaneously by the gunner. The traversing mechanism housing is flanged to the elevating mechanism housing, which, in turn, is bolted to the rear plate of the upper carriage. To insure smooth working, all shafts of the elevating and traversing mechanisms roll in ball bearings.

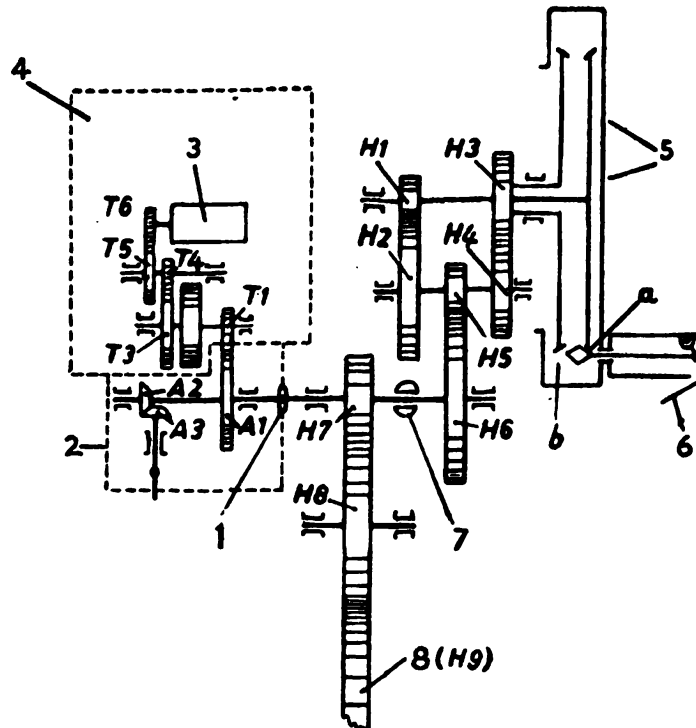
b. The connecting gear (*Anschlussgetriebe*) housing, which has an electric generator box (*Tachokasten*)<sup>10</sup> on top, is fitted to the left side of the elevating mechanism housing. Another generator box is bolted directly to the left side of the traversing mechanism. Both generator boxes are connected by electric wires to the terminals inside the switch box.

c. The vertical handwheel (*Handrad*) at the right of the housing is used for elevating; the one obliquely in front of the layer, for traversing (figs. 16 and 17). Both mechanisms have two speeds. The speeds in elevation are 4° and 12°, respectively, for each turn of the handwheel.

<sup>10</sup> The nature of the mechanism is not known, but it apparently incorporates an electric generator (*Tachodynamo*) producing a varying voltage.

d. A connecting drive shaft (*Gelenkwelle*, fig. 17②) is flanged to the end of the shaft on which the gear wheels H6 and H7 are mounted, and carries the gear A1 and the bevel wheel A2. The gear A1 engages with the gear T1 in the generator box, while the bevel wheel A2 meshes with the bevel wheel A3.<sup>11</sup>

e. The rotary movement of the elevating handwheel is transmitted to the elevating rack (*Zahnbogen*) by the gearing of the elevating mechanism through the plate clutch (*Kupplung*).



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|--|--|
| 1. Kupplung (clutch).                    | 6. Handfalle (hand catch).                             |
| 2. Anschlussgetriebe (connecting gear).  | 7. Klemmvorrichtung (clamping gear).                   |
| 3. Tachodynamo (electric generator).     | 8. H9, Zahnbogen der Wiege (elevating rack of cradle). |
| 4. Tachokasten (electric generator box). |  |
| 5. Handrad (handwheel).                  |  |

① Elevating mechanism (*Höhenrichtmaschine*).

FIGURE 17.—Layout of elevating and traversing mechanisms and generator boxes.

f. The connection of the two clutch plates to the handwheel by a pair of brake blocks is controlled by a hand catch (*Handfalle*) acting through a cam<sup>12</sup> or a cam plate (*Kurvenscheibe*, R12 in fig. 27).

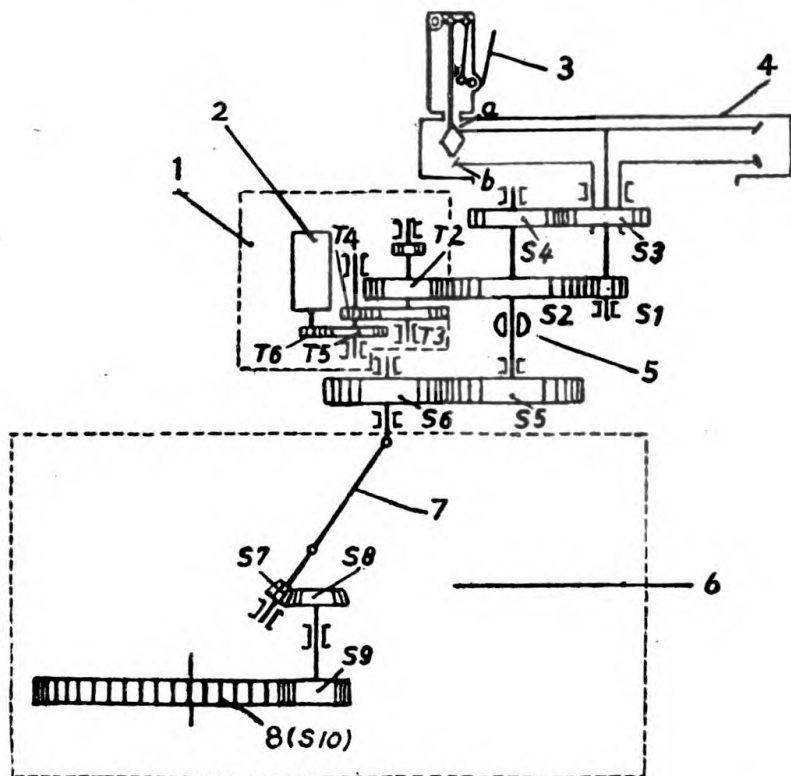
g. If the catch on the handle is not pressed, the movement of the elevating handwheels is transmitted to the elevating rack (H9) by the outer locked brake drum (diagrammatically represented by the

<sup>11</sup> The bevel wheel A3 is provided for operating the elevation limit stop to be fitted subsequently.

<sup>12</sup> Fitted only on handwheels of old pattern.

clutch, or coupled, position "a," fig. 17①) and the gears H1, H2, H5, H6, H7, and H8. This movement elevates or depresses the gun  $4^\circ$  for each turn of the handwheel.

h. By pressing the catch, the cam is so controlled that the outside clutch plate is released, whereas the inner clutch plate is locked by the action of the two helical compression springs or by the tension spring. (This position is indicated in fig. 17① by the clutch, or coupled, position "b.") Since the inner clutch plate is connected by



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|--|--|
| 1. Tachokasten (electric generator box). | 6. Seitentrieb (traversing gear).                                    |
| 2. Tachodynamo (electric generator).     | 7. Gelenkwelle (drive shaft).  |
| 3. Handfalle (hand catch).               | 8. S10, Zahnkranz des Drehringes (traversing rack of rotating ring). |
| 4. Handrad (handwheel).                  |  |
| 5. Klemmvorrichtung (clamping gear).     |  |

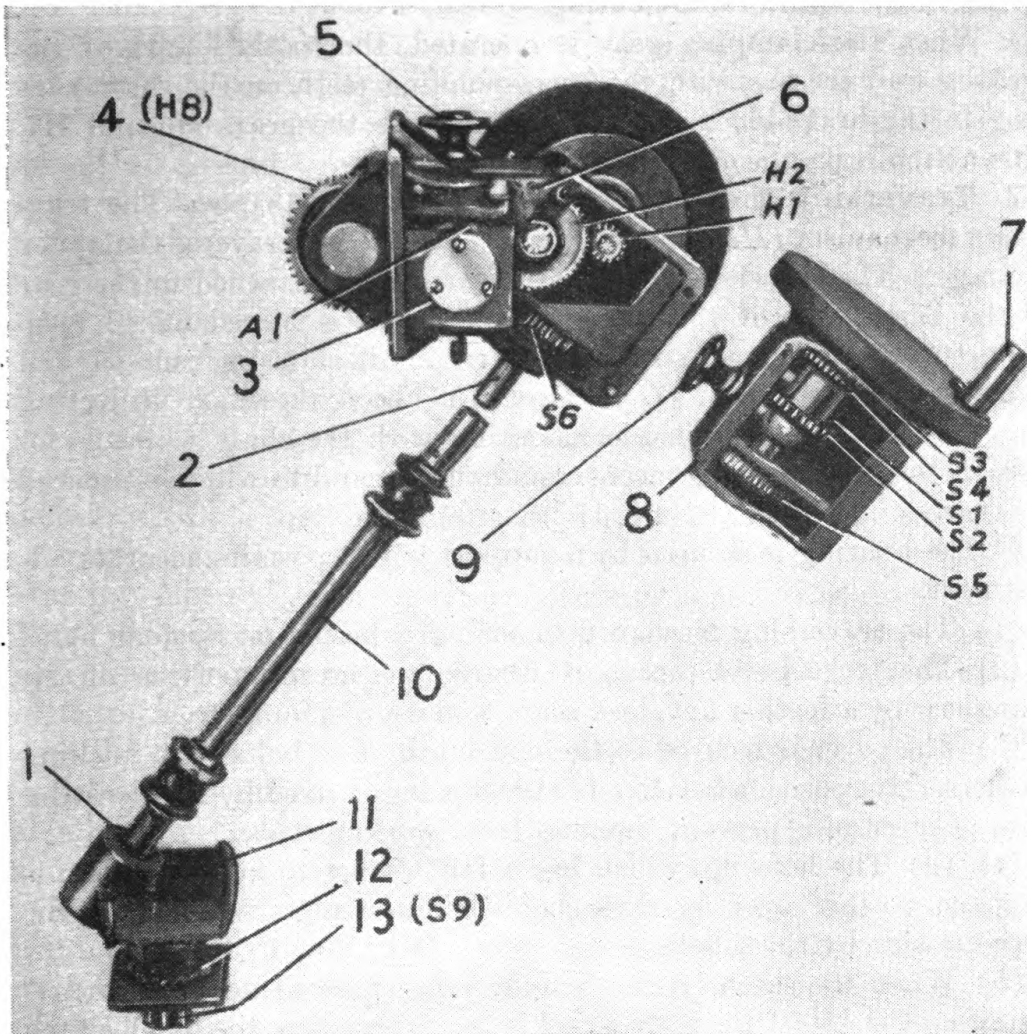
② Traversing mechanism (Seitenrichtmaschine).

Figure 17.—Layout of elevating and traversing mechanisms and generator boxes—Continued.

a sleeve with the gear H3, the rotary movement of the handwheel when the catch is not pressed is transmitted through the gears H4, H5, H6, H7, and H8 to the elevating rack (H9) of the cradle. In this case, the guns are moved  $12^\circ$  for each turn of the handwheel, or nine turns of the handwheel for the complete arm ( $-10^\circ$  to  $+100^\circ$ ).

i. Since the elevating mechanism has no self-locking gear, it is necessary to lock the elevating mechanism with the clamping gear





1. Büchse (collar).
2. Anschluss an der Gelenkwelle des Seitentriebes (connection on drive shaft of traversing gear).
3. Anschlussgetriebe (connecting gear).
4. H8 greift in den Zahnbogen, H9, der Wiege (H8 engages elevating rack, H9, of cradle).
5. Handgriff der Klemmvorrichtung für Höhenrichtmaschine (handle of clamping gear for elevating mechanism).
6. Gehäuse für Höhenrichtgetriebe (elevating gear housing).
7. Handgriff für Seitenrichtmaschine (handle for traversing mechanism).
8. Gehäuse für Seitenrichtgetriebe (traversing gear housing).
9. Handgriff der Klemmvorrichtung für Seitenrichtmaschine (handle of clamping gear for traversing mechanism).
10. Gelenkwelle (drive shaft).
11. Deckel zum Seitentriebgehäuse (cover for traversing gear housing).
12. Gehäuse des Seitentriebes (traversing gear housing).
13. S9 greift in den Zahnkranz, S10, des Drehringes (S9 engages traversing rack, S10, of rotating ring).

FIGURE 18.—Elevating and traversing mechanisms with generator box removed.

when changing barrels. Unless this is done, the cradle swings upward when the barrels are withdrawn, owing to the action of the spiral spring in the equilibrator housing.

j. When the clamping gear is operated, the toothed part of the braking unit meshes with the corresponding teeth on the shaft running in the brake-block sleeve, which carries the gears H6 and H7. This action locks the elevating mechanism.

**7. Traversing mechanism** (figs. 9, 17, and 18).—*a.* The traversing mechanism (*Höhenrichtmaschine*) is used to traverse the upper carriage. The traversing mechanism housing is attached to the rear of the base plate of the upper carriage and is closed off to keep it dustproof. The two shafts mounted in the housing run on ball bearings. A drive shaft (*Gelenkwelle*) connects the shaft projecting from the traversing mechanism housing with the shaft which is located below the elevating mechanism housing, and to which is secured the traversing pinion (S9, fig. 17②).

*b.* The housing is secured by a support which permits accurate adjustment.

(1) The traversing mechanism housing is bolted on by four bolts.

(2) The large bevel pinion is secured to the top portion of the gear shaft by a feather key, lock plate, and countersunk screw.

(3) The cover is secured to the housing by two bolts with packing washers. Its position relative to the housing is fixed by two locating pins. Cotter pins prevent the nuts from working loose.

(4) (*a*) The housing, which has a felt washer to keep out dirt, is attached to the cover by three bolts and the plate is fixed on the opposite side by three bolts.

(*b*) When the catch on the handle is not pressed down, the traversing movement of the handwheel is transmitted by the outer clutch plate to the gears S1, S2, S5, and S6, or when the catch is depressed by the inner clutch plate, to the gears S3, S4, S5, and S6, thence to the drive shaft of the traversing gear, then through the bevel pinion and wheels S7 and S8 to the traversing pinion (S9). The traversing pinion engages with the traversing rack (*Zahnkranz*, S10) of the rotating ring.

(5) In the first case (coupled position "*a*," fig. 17①), the upper carriage is traversed  $7\frac{1}{2}^\circ$ , and in the second (coupled position "*b*," fig. 17①)  $22\frac{1}{2}^\circ$ , for each turn of the handwheel. The amount of force to be exerted on the handwheel for the coarse setting averages 8.8 pounds (4 kg), and ought not to exceed the maximum of 13.2 pounds (6 kg).

(6) When the clamping gear (*Klemmvorrichtung*), which is designed as a friction brake, is actuated, the traversing mechanism

locks. The clamping member clamps the shaft running in the brake-block sleeve, which carries the gears S4, S2, and S5.

**8. Electric generators** (fig. 17).—*a.* While the guns are tracking the targets, illuminated cross wires in the sight are continuously and automatically controlled in terms of deflections and superelevation. An electric generator (*Tachodynamo*) coupled to the gears of the elevating and traversing mechanisms constantly generates voltages which vary with the speeds of laying. The generators are housed in boxes (*Tachokasten*), one being located on top of the connecting gear housing and the other bolted directly to the left side of the traversing mechanism.

*b.* The higher the laying speeds, the greater are the voltages and the changes in the position of the illuminated cross wires. The vertical wire moves in the opposite direction to the course of the aircraft, corresponding to the angular rate and the range in terms of lateral deflection, while the horizontal cross wire allows not only for course of target, angular rate, and range in terms of vertical deflection, but also for superelevation in terms of range and quadrant elevation. Thus the correct superelevation is always set in, as well as the deflection which corresponds to the angular rate, range, and course of target.

**9. Layer's seat** (figs. 8, 9, and 14).—*a.* A seat (*Richtsitz*) adjustable for height and reach is provided for the layer. The adjustable back rest (*Rückenlehne*) is rigidly connected to the actual seat and the back rest plate (*Rückenblech*).

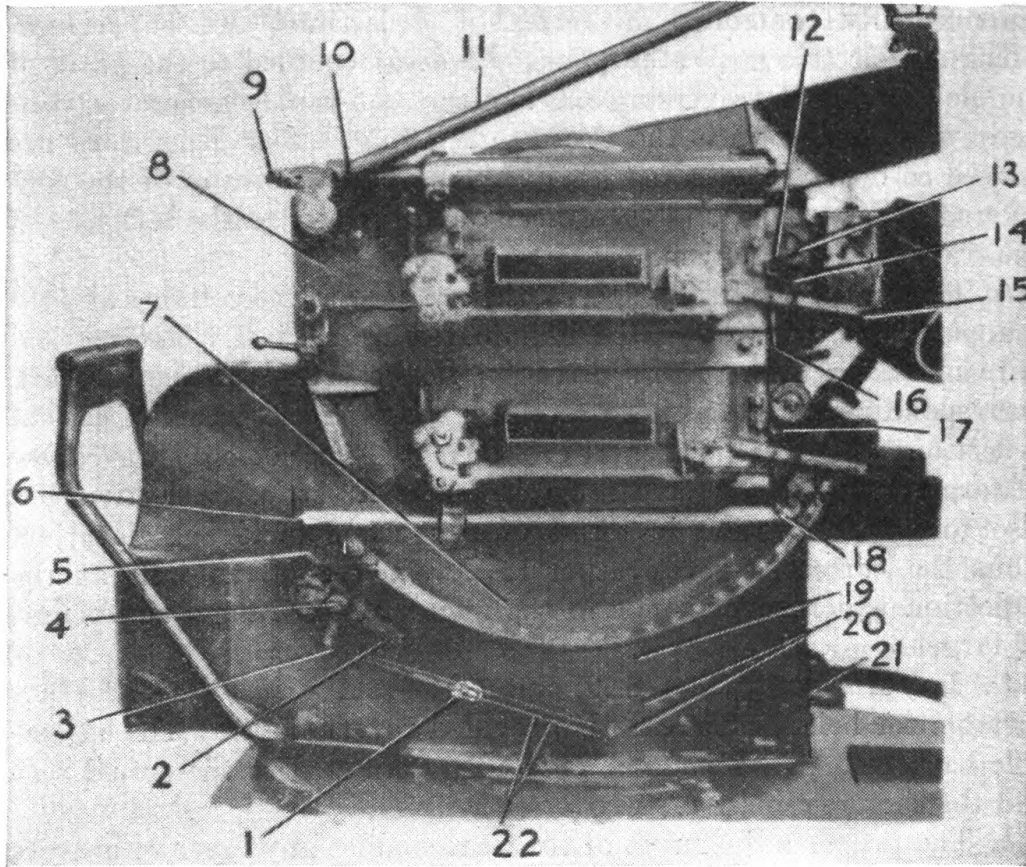
*b.* The proper adjustment of this seat enables any layer to operate comfortably the firing mechanism and the traversing and elevating mechanisms, and also to aim on the target accurately.

**10. Firing mechanism** (figs. 9, 12, 19 to 21, incl., and 25).—*a. General.*—(1) The firing mechanism (*Abzugsvorrichtung*) on the guns provides for single-shot fire (*Einzelfeuer*) or continuous fire (*Dauerfeuer*). Part of the firing mechanism is mounted on the upper carriage and part on the cradle covers.

(2) The carriage has two pedals (*Fusshebel*) for actuating the mechanism. Each pedal operates the trigger mechanisms of the two diametrically opposite guns. This arrangement permits continuous fire. While two guns are firing, the magazines on the other two guns can be changed. When both pedals are operated at once, all four guns fire together. If one or more of the guns fail, fire can be maintained with the remaining guns. Any stoppages can be corrected during pauses in fire.

(3) The following parts are on the upper carriage: firing pedals, firing rods, intermediate shafts, and angle levers. The connecting

members are butt straps, spring cups, and pull rods. Two pairs of pulleys are mounted on each carrier, together with a roller on the free end of each angle lever.



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|---|--|
| 1. Spannschlösser (turnbuckles).  | 11. Steuerstange (control rod).                      |
| 2. Halter (holder).   | 12. Kreuzlochschaube (cross hole screw).             |
| 3. Spannfeder für Seilzug (tension spring for cable-pulley unit).   | 13. Umlenkrolle (deflecting pulley).                 |
| 4. Winkelhebel (angle lever).   | 14. Seilzug 1 (cable-pulley unit 1).                 |
| 5. Seilrollen (cable pulleys).  | 15. Abzugsschiene (trigger bar).                     |
| 6. Bolzen (bolts).  | 16. Rückholfeder (recuperator spring).               |
| 7. Seilrollenträger mit Höhenrichtgradbogen (cable drum bracket with graduated quadrant of elevating device). | 17. Seilzug 4 (cable-pulley unit 4).                 |
| 8. Deckel der Wiege (cover of cradle).  | 18. Abschlussmutter (female screw used as shut-off). |
| 9. Splint (cotter).   | 19. Oberlafette (upper carriage).                    |
| 10. Lagerbock (coupler recess).   | 20. Zwischenwellen (intermediate shafts).            |
|   | 21. Abzugswelle (firing rod).                        |
|   | 22. Zugstangen (pull rods).                          |

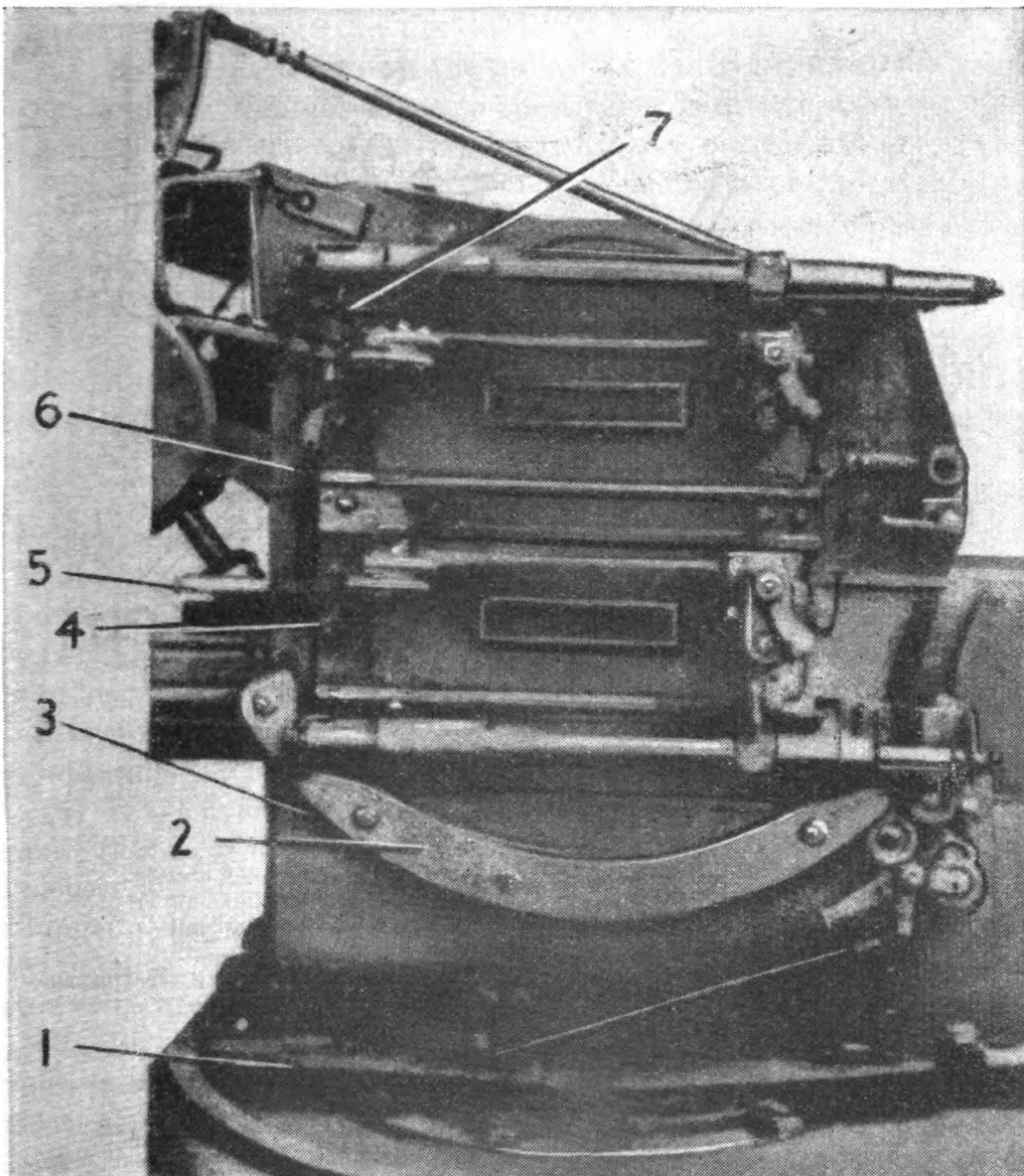
FIGURE 19.—Firing mechanism with guns, protecting boxes, and platform removed—left side view.

(4) The parts mounted on the outer plates of the upper carriage are covered by protecting boxes.

(5) Each cradle cover carries the cable drum bracket (*Seilrollenträger*) with five pairs of cable pulleys, the firing rods, and the special screws acting as stops, and, on the left cover, the two deflecting pulleys (*Umlenkrollen*).



(6) The firing rods (*Abzugswellen*) work in conjunction with the rollers which are housed in the trigger guards of the guns. The en-

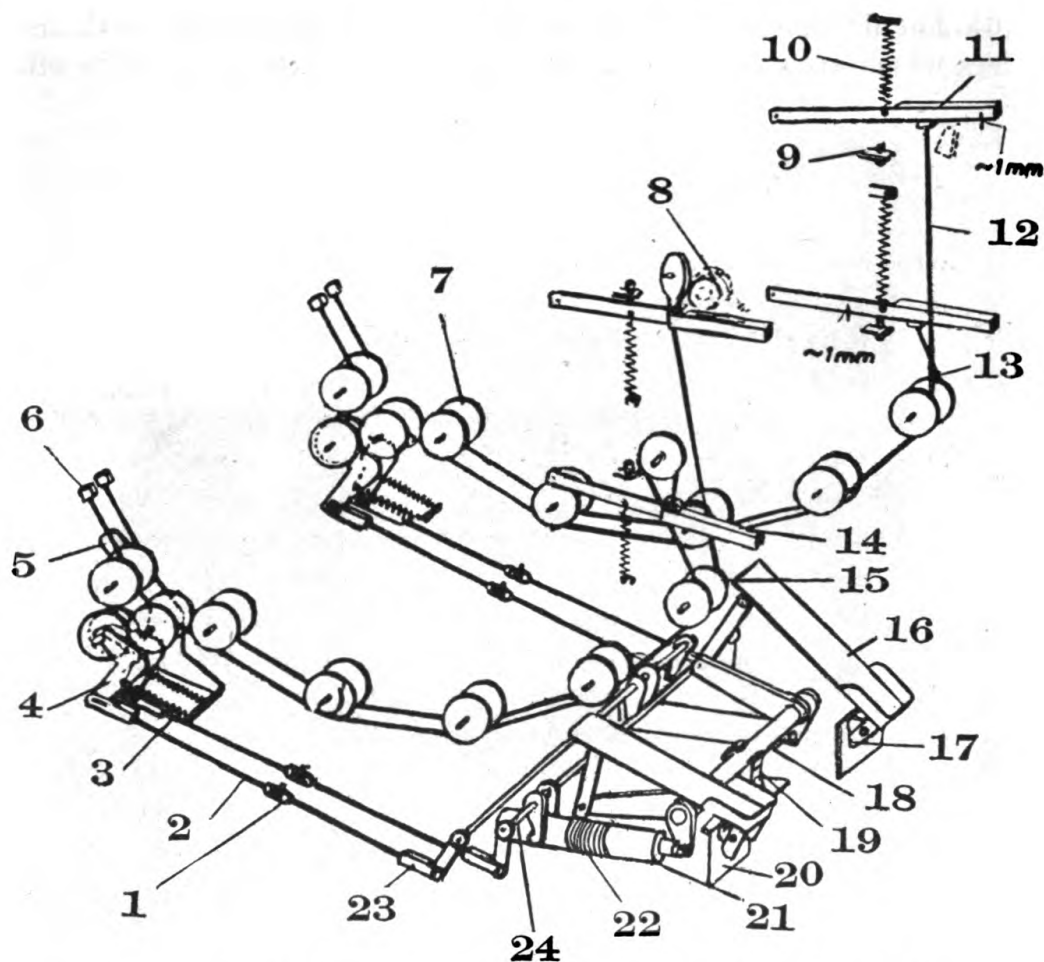


- |   |                                       |
|---|---------------------------------------|
| 1. Seitenteilring (azimuth scale).        | 5. Abzugsschiene (trigger bar).       |
| 2. Seilrollenträger (cable drum bracket). | 6. Seilzug 2 (cable-pulley unit 2).   |
| 3. Oberlafette (upper carriage).          | 7. Rückholfeder (recuperator spring). |
| 4. Seilzug 3 (cable-pulley unit 3).       |                                       |

FIGURE 20.—Firing mechanism with left foot lever down, guns dismounted, protecting box and platform removed—right side view.

tire firing mechanism is maintained in the rest position by means of springs hooked onto the firing rods and covers.

(7) When the firing mechanism is actuated, either two guns diametrically opposite (one top gun and the opposite bottom gun),



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|--|--|
| 1. Spannschloss (turnbuckle).                            | 13. Seilzug 3 (cable-pulley unit 3).                   |
| 2. Zugstange (pull rod).                                 | 14. Seilzug 1 (cable-pulley unit 1).                   |
| 3. Spannfeder (tension spring).                          | 15. Seilzug 4 (cable-pulley unit 4).                   |
| 4. Winkelhebel (angle lever).                            | 16. Fusshebel (pedal).                                 |
| 5. Halter an der Oberlafette (collar on upper carriage). | 17. Lagerbügel mit Anschlag (bearing guard with stop). |
| 6. Kugelhalter (thrust collar).                          | 18. Abzugswelle (firing rod).                          |
| 7. Seilrolle (cable pulley).                             | 19. Lagerbock (coupler recess).                        |
| 8. Abfeuerungsbügel der Waffe (firing guard of gun).     | 20. Abdeckblech (removable cover plate).               |
| 9. Kreuzlochschraube (cross hole screw).                 | 21. Federkopf (spring stud).                           |
| 10. Rückholfeder (recuperator spring).                   | 22. Überzugsfeder (control spring).                    |
| 11. Abzugsschiene (trigger bar).                         | 23. Gabelkopf, unterer (bracket head, lower).          |
| 12. Seilzug 2 (cable-pulley unit 2).                     | 24. Zwischenwelle (intermediate shaft).                |

FIGURE 21.—Firing mechanism—schematic diagram.

or all four of them, are fired. The firing diagram is marked on the battery box as follows:

(a) *Right foot*.—Right top and left bottom gun (2 R and 4 L).

(b) *Left foot*.—Left top and right bottom gun (1 L and 3 R).

b. *Functioning* (figs. 9, 12, and 19 to 21, incl.).—(1) By operating one of the two firing pedals a short rotary movement is imparted to the corresponding firing rod (*Abzugswelle*); this withdraws the

spring-loaded pulley slightly. A rotary motion is thus imparted to the intermediate shaft (*Zwischenwelle*), and this, acting through the two pull rods (*Zugstangen*) on the shaft, actuates the angle levers (*Winkelhebel*) pivoted to the carriers.

(2) The cables fitted over the pulleys at the free ends of the angle levers transfer the movement to the trigger bars (*Abzugsschienen*). When all parts are correctly adjusted, these movements are transmitted simultaneously to the firing mechanisms of the respective guns, the trigger bars on the left side being raised and those on the right side lowered.

(3) (a) When the guns are ready for firing (cocked, loaded, "safety" released, and set for continuous fire), the two guns diametrically opposite (top right and bottom left, or top left and bottom right) continue firing until the magazines are empty or until the layer removes his foot from the firing pedal.

(b) When pressure is released from the pedal, the tension return springs held in position on the firing rods return all moving parts of the firing mechanism to the initial position until the stop edges of the bearing guard of the pedal butts against the cover plate.

(4) The object of the tension return springs on the angle levers is to keep the cable pulleys and cables in the proper position. If, for instance, the spring should fail, moving one of the firing rods by hand would cause the particular cable to come off its pulley.

(5) If the firing mechanism is operated with more force than necessary (that is, if one of the diametrically opposite guns inadvertently has been left at "safe"), compression of the control spring fitted in the plunger cylinder will prevent too much force from being put on the firing parts. This explains why one of the diametrically opposite guns cannot be fired when the other is set at "safe."

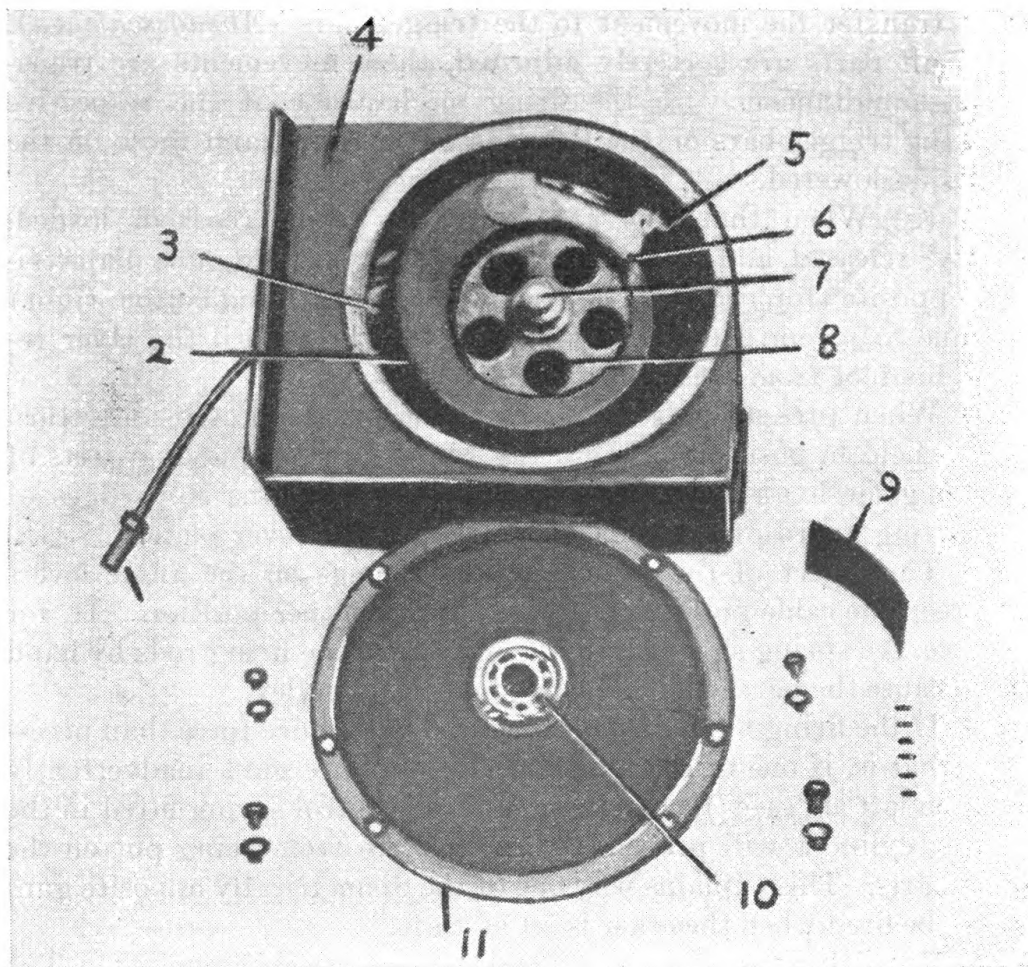
**11. Equilibrator** (figs. 8, 22, and 23).—*a. Description.*—(1) The equilibrator (*Ausgleicher*) is bolted to the front plate of the upper carriage.

(2) A pinion shaft (*Ritzelwelle*) and a shaft for a spiral spring (*Spiralfeder*) are mounted in the equilibrator housing and in ball bearings housed in the right and left covers, the covers being bolted to the housing. The pinion shaft carries a cam plate (*Kurvenscheibe*) to which a cable is attached. This cable engages on the pulley bolted to the right drum (*Trommel*) of the cradle (see fig. 24). An opening in front of the housing, covered by a dust cover, gives access to an adjusting nut.

(3) The pinion meshes with a gear mounted on the same shaft as the spiral spring. The extreme ends of the two spiral springs

are maintained in position in the equilibrator housing by a tension spring (*Zusatzfeder*).

(4) A distance washer and a lock ring prevent lateral displacement of the spiral springs and the shaft.



- |   |   |
|---|---|
| 1. T-Stück des Seiles (T-piece of cable).                         | 6. Kurvenscheibe (cam plate).                       |
| 2. Welle des Spiralfedersatzes (shaft of spiral spring assembly). | 7. Ritzelwelle (pinion shaft).                      |
| 3. Zahnrad (gear wheel).  | 8. Ritzel (pinion).                                 |
| 4. Gehäuse des Ausgleichers (equilibrator housing).               | 9. Schutzdeckel (protecting cover).                 |
| 5. Mutterschraube (female screw).                                 | 10. Kugellager (ball bearing).                      |
|   | 11. Rechter Gehäusedeckel (cover of right housing). |

FIGURE 22.—Equilibrator with cover removed.

(5) The gear wheel (*Zahnrad*) and cam plate are keyed to the shaft.

(6) The tension spring is kept in position on the equilibrator housing by bolts.

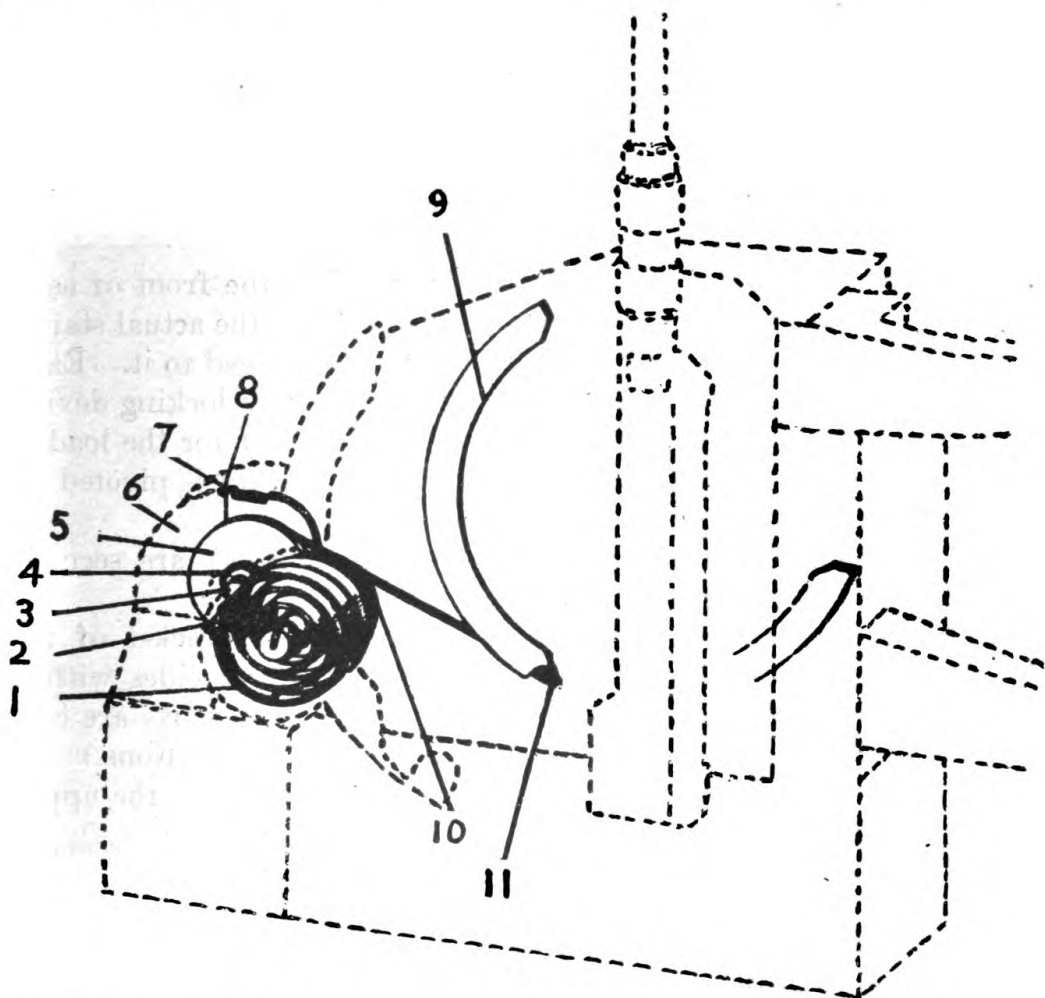
*b. Functioning.*—(1) With the guns elevated to 90°, the two spiral equilibrator springs have practically no initial tension. When the



cradle is depressed, the muzzle preponderance is increased, and at the same time the tension of the spiral spring increases and helps to support the guns through added tension on the equilibrator cable.

(2) Spiral spring tension is greatest at low elevations and decreases as the guns are elevated. This compensates the action of muzzle preponderance, which is greatest at low elevations and smallest at high elevations.

(3) If the equilibrator is correctly adjusted when assembled by the manufacturers, a steady manual force averaging roughly 6.6 pounds (3 kg) should be applied to the handwheel throughout the range of elevation.



- |   |  |
|---|--|
| 1. Spiralfeder (spiral spring).                     | 7. Schutzdeckel (protecting cover).        |
| 2. Zusatzfeder (tension spring).                    | 8. Mutterschraube (female screw).          |
| 3. Ritzelwelle (pinion shaft).                      | 9. Seilscheibe (cable pulley disk).        |
| 4. Ritzel (pinion).                                 | 10. Zahnrad (gear wheel).                  |
| 5. Kurvenscheibe (cam plate).                       | 11. T-Stück des Seiles (T-piece of cable). |
| 6. Gehäuse des Ausgleichers (equilibrator housing). |  |

FIGURE 23.—Equilibrator—schematic diagram.

**12. Deflector box** (figs. 1, 8, 12, 14, and 15).—The deflector box (*Hülsenkasten*) fixed underneath the equilibrator housing catches the empty cartridge cases which are ejected from the guns and deflected along the runway plates. When this box is half open, it holds about 500 cases. These cases may be removed from the containers with the aid of a cartridge case remover found in the trail box.

*a.* On the front of the box, a cover hinged on two pins can be held in three positions by a wing nut (*Flügelmutter*): closed, half open, and wide open.

*b.* The empty deflector box has a beaded edge and is attached to the equilibrator housing by bolts.

*c.* The wing nut is screwed to a threaded pin riveted to the deflector box.

**13. Platform** (figs. 1, 8, and 14).—*a.* The platform (*Plattform*) is in two halves which are bolted to the left and right of the upper carriage. The platform can support the gun commander, the layer, and the loaders, and enables them to carry on while the gun is being traversed.

*b.* A magazine rack (*Magazinlager*) is bolted to the front of each half of the platform, the rear portion of which forms the actual standing surface and is extended by a shorter platform hinged to it. Each of these platform halves when tipped up, is held by a locking device, on the outer side of which is a hinged seat (*Ladesitz*) for the loader. The seat has a low back rest. The footrest (*Fussstütze*) is pivoted by a ring and pin to each half of the platform.

*c.* Four interchangeable wooden strips (*Holzleisten*) are secured to each of the standing surfaces.

*d.* In the latest type of mount, the rear carrier bracket of the right half of the platform has a red mark which coincides with a corresponding mark on the triangular base when both parts are correctly in position. (This mark is not shown in the illustrations.)

*e.* Each half of the platform is secured to the outside of the upper carriage by nine bolts.

*f.* The wooden strips can be unclipped when the standing boards have to be cleaned. The spacers welded to the platforms insure that the wooden strips are evenly spaced.

*g.* In front of each platform is the bracket for fitting the two halves of the shield.

**14. Magazine rack** (figs. 1, 8, 9, and 14).—*a.* Each of the two magazine racks (*Magazinlager*) takes eight magazines (each containing 20 rounds in two staggered rows). The magazines are carried on the platform in front of the loaders' seats in order to enable them to be changed quickly.

b. The magazine rack is divided into eight shelves (*Holzfutter*), each wood-lined to protect the lips of the magazines. Eight drainage holes in the sloping bottom allow water that has penetrated the container to drain away.

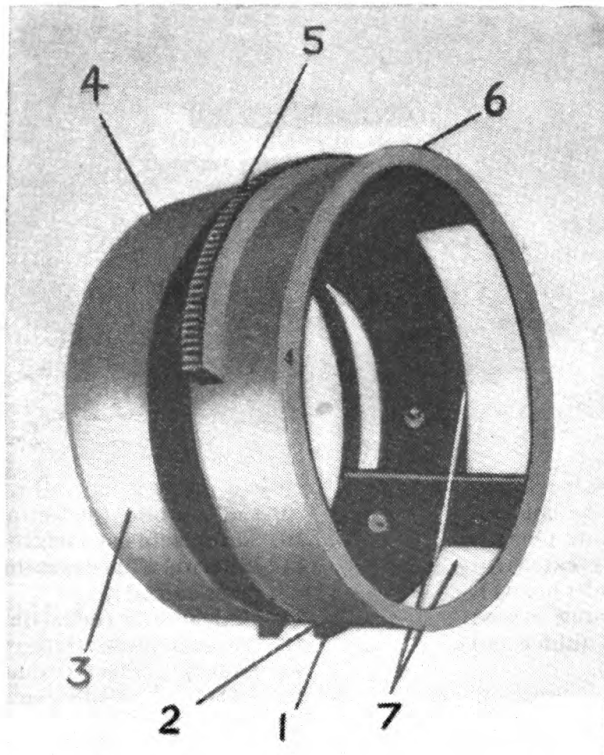
c. On the rear side of each magazine rack is a tube (*Aufnahme*) containing a bent rod (*Winkelstock*).

d. The magazine racks are strengthened by heading, and are bolted to the platforms.

**15. Locking mechanism** (figs. 8, 14, 15, and 25).—a. The elevation and traverse locking mechanism (*Zurrung*) is pivotally attached to the front bottom part of the upper carriage.

b. The locking pins (*Zurrbolzen*) located in the cradle covers engage in the upper cross tube and thus lock the cradle. This locking arrangement operates at only about 12° elevation.

c. When the cradle is locked, the tongue on the lower cross tube is between the small stops welded on in front of the lower carriage, thus preventing the upper carriage from swinging sideways.

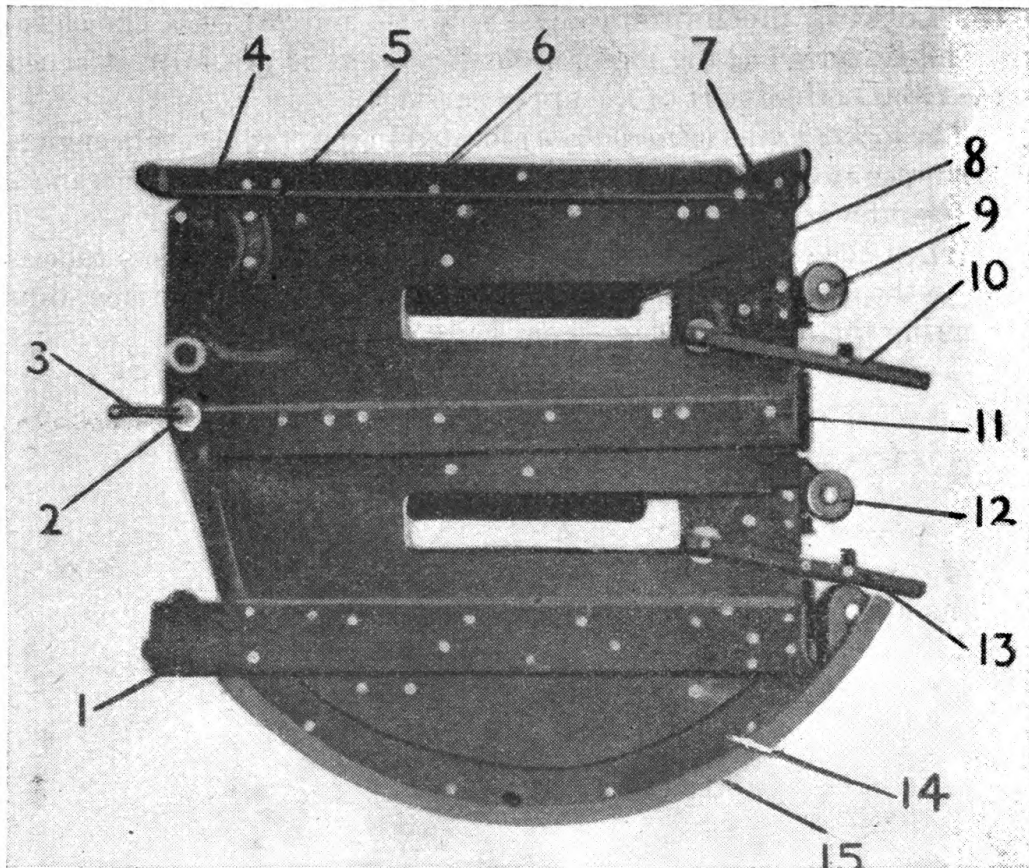


- |   |  |
|---|--|
| 1. Blattfeder (leaf spring).  | 5. Zahnbogen (elevating rack).                   |
| 2. Seilscheibe (cable pulley disk).   | 6. Linke Trommel (left drum).                    |
| 3. Rechte Trommel (right drum).   | 7. Ausschnitte zum Durchtreten der Hülsen        |
| 4. Nasen zur Begrenzung des Erhöhungsbereichs (lugs for limiting arc of elevation). | (cutaways for passage of empty cartridge cases). |

FIGURE 24.—Cradle with cover removed.

d. When the locking device is not engaged, the tongue comes up against a stop located below the base plate and the locking mechanism tips down.

e. To insure that the locking mechanism does not prevent the vertical movement of the cradle, a rejector is fitted on the right locking strut. This prevents the cradle from fouling the upper cross tube of the locking mechanism.



- |   |   |
|---|---|
| 1. Bremshalter (brake holder).                          | 9. Umlenkrolle (deflecting pulley).                         |
| 2. Zurrbolzen (locking pins).                           | 10. Abzugsschiene (trigger bar).                            |
| 3. Rasthebel (safety catch).                            | 11. Mittlere Führungsschiene (intermediate guide rail).     |
| 4. Bremshalter (brake holder).                          | 12. Umlenkrolle (deflecting pulley).                        |
| 5. Lagerbock (coupling recess).                         | 13. Abzugsschiene (trigger bar).                            |
| 6. Führungsschiene (guide rail).                        | 14. Seilrollenträger (cable drum bracket).                  |
| 7. Lager (bearings).                                    | 15. Höhenrichtgradbogen (graduated quadrant for elevation). |
| 8. Hülsenableiter (deflector of empty cartridge cases). |   |

FIGURE 25.—Left cover with cable drum bracket, trigger bars, and deflecting pulleys.

**16. Cradle** (figs. 8, 12, 24, and 25).—a. (1) The elevating mechanism and the cradle (*Wiege*) are used for elevating the gun. On the cradle cover are the guide rails (*Führungsschienen*) for the gun lugs, the supports for the recoil gear, the locking pins (*Zurrbolzen*), and part of the firing mechanism.

(2) The cradle is pivotally supported inside the upper carriage, the two drums being clamped to the inner race of the ball bearings incorporated in the upper carriage.

b. The pulley on which rests the wire cable leading to the cam plate of the equilibrator is on the inner side of the right drum. The cable is prevented from loosening by the leaf spring (*Blattfeder*) engaging above the T-piece of the cable. The two projecting lugs on the right drum butt against the stop on the upper carriage at  $-10^\circ$  and  $+100^\circ$ , thus limiting the arc of elevation of the cradle.

c. The rack with which the elevating pinion of the elevating mechanism engages is bolted to the left drum.

d. Since cartridge cases, which are ejected as the gun fires, pass into the drums, each drum is closed by a web inside and by a cover outside. There is a subdivided cutaway located at approximately  $140^\circ$ , and through this the empty cartridge cases pass, at any elevation of the barrel, over the runways of the upper carriage and then into the deflector box.

e. On the outsides of both covers are the guide rails for the sleighs, the bearing housings for the recoil gear, locking pins, and cable pulley carriers; the deflector box is on the inside. The bracket to which the control rod is hinged is secured on the top front part of the left cover, below the brake carrier bracket. The rear end of this rod is hinged to the pivoting arm of the sight bracket. The rod has a turnbuckle for adjusting its length. The elevating arc is bolted to the left cable bracket.

f. Lengthwise openings for the sleighs are provided in the covers between the guide rails; the ejected cartridge cases pass through these openings to the inside of the drums. Behind these openings are recesses for insertion of the firing rods. (For additional parts of the firing mechanism attached to the covers, see par. 10a(5).)

g. (1) The deflector boxes are fixed to the inner sides of the covers above the openings. The ejected cases do not jump back but are properly deflected, whatever the elevation of the cradle.

(2) To increase rigidity, the two covers are connected in front by a tube. Below this tube, the locking pins are supported in the covers. These pins are controlled by levers operated externally.

h. The drums are connected by 10 bolts and 2 studs.

(1) The cable pulley is secured to the inside of the left drum by two locating pins and six bolts.

(2) The leaf spring is fastened on the right side of the cable pulley by two locking screws secured with wire.

(3) Each cover is secured to its drum by a spanning pin and is fixed with 12 bolts. Between the cover and the drum a protecting

ring is clamped in position on either side, and engages with the ring (see fig. 13) on the upper carriage.

(4) The bracket on which the control rod hinges is positioned in relation to the left cover by two straight pins and is secured by four bolts.

(5) The recoil gears are carried by buffer carriers in front and by bearings behind. Each buffer carrier and bearing is held in position by two pins, and by two and three bolts, respectively.

(6) The guide rails and center rails are secured to the covers by pins and five bolts.

(7) The deflector box is fixed to the inside of the covers by three countersunk bolts.

**17. Sleighs** (figs. 11, 12, 14, and 26).—*a.* There are two sleighs (*Schlitten*) on each side of the cradle. These carry the guns and recoil gears. The tubes supporting the recoil gears are secured to the covers, while the gun lugs (which recoil after fire) cause the buffer cylinders to recoil with them and so actuate the recoil mechanism (*Rücklaufeinrichtung*) proper.

*b.* (1) The sleighs allow each gun to recoil separately and to slide in the guide rails (*Gleitschienen*) fitted on the cradle covers. Their driving cams engage with the corresponding recoil mechanisms.

(2) To the top and bottom of the sleighs in two grooves are secured the slides which guide the sleighs. The vertical wall of the sleighs has a square-section cutaway (*Durchtrittsöffnung*) for the passage of the empty cartridge cases.

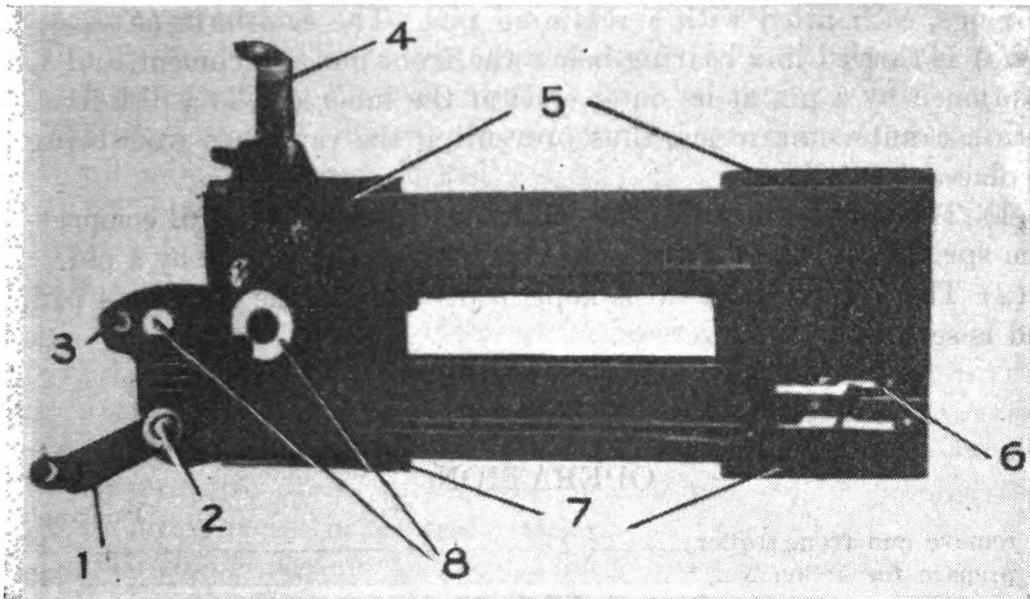
*c.* The operating cams are also fitted to the sleighs. These are attached to the top of the upper left and lower right sleighs, and to the bottom of the upper right and lower left sleighs. The lugs of these operating cams engage in the narrow recesses of the buffer cylinders and thus transmit the movements of the sleighs to the recoil gears.

*d.* The gun lug is in front of the sleigh. It has two retaining bolts (*Haltebolzen*) which are actuated simultaneously by the crank arm (*Kurbelarm*) working in conjunction with a rod. The crank arm has a handle (*Griff*) which contains the locking bolt.

*e.* The rear gun holder (*Waffenaufnahme*) is secured to the rear portion of the sleigh. It consists of a yoke-shaped pedestal bearing. The forked recess (*Lagerbock*) receives the breech of the gun. The rear gun attachment also has a lock (*Sperre*) which prevents the gun from falling out when the cradle is elevated and the retaining bolt (*Riegelbolzen*) of the front gun attachment is released.

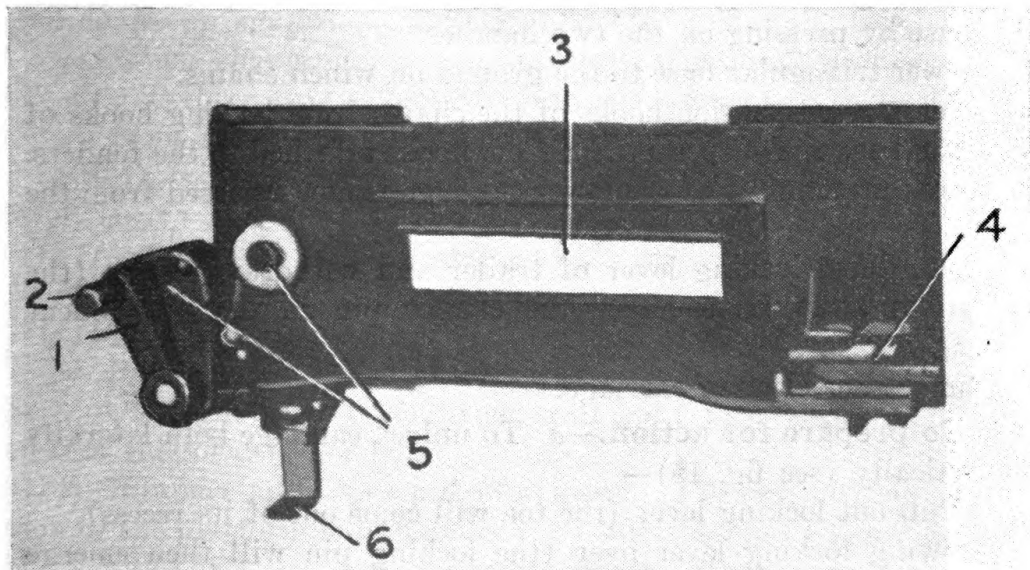
*f.* The actuating cams are secured by bolts and any thrust is taken by shear pins. The front gun attachment consists of two bushed





- |   |   |
|---|---|
| 1. Kurbelarm vorgeschwenkt (crank arm swung forward).               | 5. Gleitschienen (guide rails).   |
| 2. Kurvenwelle (camshaft).  | 6. Lagerbock der hinteren Waffenaufnahme mit Sperre (forked recess of rear gun holder with lock). |
| 3. Rastloch für Riegelbolzen (stop hole for retaining bolt).        | 7. Gleitschienen (guide rails).   |
| 4. Mitnehmer für Rücklafeinrichtung (carrier for recoil mechanism). | 8. Haltebolzen herausgezogen (retaining bolts pulled out).  |

① Upper left and lower right.



- |   |  |
|---|--|
| 1. Kurbelarm in Raststellung (crank arm in rest position).            | 4. Gabelförmige Ausnehmung der hinteren Waffenaufnahme mit Sperre (yoke-shaped pedestal bearing of rear gun holder with lock). |
| 2. Griff (handle).  | 5. Haltebolzen der vorderen Waffenaufnahme (retaining bolts of forward gun holder).  |
| 3. Durchtrittsöffnung für Hülsen (cutaway for empty cartridge cases). | 6. Mitnehmer für Rücklafeinrichtung (carrier for recoil mechanism).  |

② Upper right and lower left.

FIGURE 26.—Sleighs.

bearings, each fitted with a retaining pin. The camshaft (*Kurvenwelle*) is carried in a bearing below the front gun attachment, and is positioned by a pin at its outer end; at the inner end is a disk fixed with a countersunk screw, thus preventing the camshaft from being displaced laterally.

(1) The sleeve welded to the crank arm houses the spiral compression springs and the locking bolt connected to the handle by a pin.

(2) The bearing pedestal is kept in position on the slide by a pin, and is secured by four screws.

### SECTION III

#### OPERATION

	Paragraph
To remove gun from trailer.....	18
To prepare for action.....	19
To elevate and traverse.....	20
To fire.....	21

**18. To remove gun from trailer** (figs. 6 and 10).—*a.* Lower lunette of special trailer until leveling plate rests on the ground.

*b.* Use chain winches to bring triangular base to bear upon frame of the trailer.

*c.* Disengage locking hooks of trailer from carrier pins of triangular base by pressing on the two handles.

*d.* Lower triangular base to the ground on winch chains.

*e.* Disengage suspension hooks of the chains from locking hooks of triangular base and suspend them from hooks attached to the fenders. (The front attachment of the lower carriage is now released from the trailer.)

*f.* Press down locking lever of trailer and withdraw trailer (the hook slides away from under the carrier pin in the attachment bracket).

*g.* Run trailer clear of carriage.

**19. To prepare for action.**—*a.* To unlock carriage both laterally and vertically (see fig. 15)—

(1) Pull out locking lever (the toe will come out of its recess).

(2) Swing locking lever over (the locking pin will then emerge from the cross tube).

(3) Elevate cradle slightly and move locking lever to the front until it rests against its stop.

*b.* To set up the platform (see fig. 14)—

(1) Pull up locking lever (releasing the lock).

(2) Release platform.



c. To raise loaders' seats (see fig. 14)—

(1) Push up handle in seat (the locking pin is withdrawn from the elevating rack of the seat support).

(2) Raise seat, and allow locking pin to engage in upper notch (the seat will now be properly locked).

(3) Put footrests into lower locked position in front of bolted-on platform halves (spring clips keep the footrests firmly in both positions).

d. To adjust the layer's seat to suit the layer's height—

(1) *Vertically*.—(a) Push back locking handle into lower pivoting bracket (the locking pin will come out of the notch in the seat).

(b) Lower layer's seat until it engages in the proper notch. (Under pressure of its spring, the locking pin will engage in the corresponding recess in the seat rest.)

(c) To change layer's seat to traveling position, raise it.

(2) *Horizontally*.—(a) Push down projecting lever from behind (the lever will withdraw the hinged pin from the locking holes under the seat).

(b) Move layer's seat and allow spring on the pin to engage the latter in the required position (the seat will now be locked).

(c) When moving layer's seat backward or forward, any unintentional withdrawal is prevented by a stop screwed to the guide. This stop comes up against a counterstop welded under the seat.

(d) When changing over to traveling position, clamp seat into one of the three rear notches to prevent catch of lateral clamping device from being damaged when moved upward.

e. With the leveling screws, level carriage with the aid of spirit level.

f. Open deflector box half way.

g. Place the following accessories ready for use:

(1) Cartridge case remover found in trail box.

(2) Belts to strap gunners in when firing from moving vehicles.

(3) One bent rod (taken from trail box) to be inserted in hole on rear side of deflector box.

(4) Hammer and taper pin (for loosening breech mechanism) on each of the platform halves under the loaders' seats. (These are kept in the trail box.)

(5) Firing pin to be laid on each of the platform halves.

h. Remove covers from guns and lay them down between magazine racks and upper carriage.

i. Cock breech mechanisms and set them at "safe."

j. Set guns for continuous or single-shot fire.

*k.* Place 16 full magazines in the 2 magazine racks. (The tips of magazines should point downward, and the tips of cartridges should point toward the mount.)

*l.* Remove sight head 38/40 from its box end, and, with the locking screw slackened off, attach it to the sight bracket. Then tighten the screw.

*m.* Adjust the sight.

*n.* Take two full magazines from each magazine rack and insert them in the gun.

*o.* Turn the safety to the "fire" position on each gun, as there is no safety device on the mount.

*p.* Proceed in reverse order when putting the gun back on the trailer.

**20. To elevate and traverse** (figs. 17 and 18).—The layer operates both gears while sitting. He operates the elevating handwheel with his right hand, the traversing handwheel with his left.

*a. To elevate.*—(1) By turning the elevating handwheel forward and downward, the gun is depressed; by turning the handwheel in the opposite direction, the gun is elevated.

(2) If the catch on the handwheel is not pressed, the cradle elevates or depresses  $4^{\circ}$  for each turn of the handwheel. If the catch on the handwheel is pressed, the cradle moves  $12^{\circ}$  for each turn of the handwheel.

*b. To traverse.*—(1) The traverse of the carriage corresponds to the direction in which the handwheel is turned.

(2) If the catch on the handwheel is not pressed, the upper carriage rotates  $7\frac{1}{2}^{\circ}$  per turn of the handwheel. If the catch on the handwheel is pressed, the upper carriage rotates  $22\frac{1}{2}^{\circ}$  for each turn of the handwheel.

**21. To fire.**—*a. Right pedal.*—This pedal operates the upper right gun and the lower left gun (2 R and 4 L).

*b. Left pedal.*—This pedal operates the upper left gun and the lower right gun (1 L and 3 R).

## SECTION IV

### INSPECTION AND ADJUSTMENT

General.....	Paragraph 22
Inspection and adjustment.....	23

**22. General.**—If the guns and carriage are carefully looked after and handled, they will function smoothly and have a long service life. Inspection should be carried out whenever the matériel is used, cleaned, or disassembled.

**23. Inspection and adjustment.***Inspection**Adjustment*

- |  |  |
|--|--|
| <p><i>a. Traversing mechanism.</i>—(1) Set up carriage in firing position and level by means of leveling jacks. Test functioning of traversing mechanism.</p> <p>(2) Note whether catch on handwheel changes gear ratio properly.</p> <p>(3) At the high speed position the handwheel load should be between approximately 9 and 13 pounds.</p> <p><i>b. Elevating mechanism.</i>—(1) Set up carriage in firing position and level by means of leveling jacks. Test functioning of elevating mechanism.</p> <p>(2) Note whether catch on handwheel changes gear ratio properly.</p> <p>(3) Note action of equilibrator. At the high speed position the handwheel load should be between approximately <math>6\frac{1}{2}</math> and 9 pounds throughout the full range of elevation.</p> | <p><i>a.</i> (1) If the mechanism does not operate smoothly, check it for proper lubrication. Malfunctioning might be due to dirt in the gear mechanisms, or to damaged gears and bearings, or to improper assembling.</p> <p>(2) Notify maintenance personnel if the catch does not work.</p> <p>(3) High handwheel loads might be due to insufficient lubrication or to dirty or defective gear mechanisms.</p> <p><i>b.</i> (1) If the mechanism does not operate smoothly, check it for proper lubrication. Malfunctioning might be due to dirt in the gear mechanisms, or to damaged gears and bearings, or to improper assembling.</p> <p>(2) Notify maintenance personnel if the catch does not work.</p> <p>(3) High handwheel loads might be due to insufficient lubrication, or to dirty or defective gear mechanisms, or to a defective equilibrator. Adjustment of the equilibrator might correct erratic or high handwheel loads.</p> |
|--|--|

*Inspection*

*c. Firing mechanism.*—Operate pedals and see whether guns function.

*d. Leveling mechanism.*—(1) Operate leveling screws through their entire length.

(2) Note action of spirit level while turning leveling screws.

*e. Control rod.*—Elevate and depress cradle through the entire range and note action of control rod.

*f. Locking mechanism.*—Test to see that locking mechanism works properly. The upper carriage can be locked in position both vertically and laterally if locking mechanism is in order.

*Adjustment*

*c.* If the guns do not fire, check firing mechanism to see that all parts are working easily and properly. The rods may be bent, the cables may need adjustment, or the springs may be broken.

*d.* (1) If the screws are stiff, lubricate them. If they are damaged, maintenance personnel must repair the threads.

(2) Replace spirit level if it is broken or missing.

*e.* Adjust or repair control rod so that it operates properly.

*f.* Repair or replace broken or bent parts.

## SECTION V

## CARE AND PRESERVATION

	Paragraph
Care and cleaning.....	24
Lubrication.....	25

**24. Care and cleaning.**—*a.* As far as possible, protect the matériel from dust, dirt, and moisture.

*b.* When the matériel is not in use or is being transported, and, if possible, even when it is emplaced, the appropriate covers should be used for protection.

*c.* Keep cleaning cloths free from sand, dust, dirt, and moisture. Wash painted parts with soap and water or with water alone.

*d.* Each time after the matériel has been used (if possible, immediately after), carefully remove all dirt and moisture and clean; then

coat all bright and metal parts with a very thin film of oil as indicated in the chart in paragraph 25*b*.

*e.* See that all indicator marks and graduations which are important for operation of the mount are plainly visible.

*f.* When disassembling, give special care to the cleaning of all threads, grooves, springs, joints, and guides.

*g.* When the matériel has been out of use for a fairly long time and is coated with old oil or preservative material, clean with solvent, dry-cleaning, and oil as indicated in the chart in paragraph 25*b*.

**25. Lubrication.**—*a. Lubricants.*—The following lubricants will be used for lubrication of the 2-cm Flakvierling 38:

Oil, engine, SAE 30, above +32° F.; SAE 10, below +32° F.

Grease, O. D., No. 0, above +32° F.; No. 00, below +32° F.

Grease, general purpose, No. 2, all temperatures.

Oil, lubricating, preservative, light.

*b. Lubrication chart.*

Location	Lubricant	Interval
Pressure lubrication fittings (painted red).	Grease, O. D.-----	Monthly.
Linkages, pins, clevises, etc.	Oil, engine-----	Daily in active service.
Wheel bearings-----	Grease, general purpose, No. 2.	Every 6 months. Remove wheels, clean bearings, and repack with grease.
Gear cases-----	Grease, O. D.-----	At time of ordnance inspection. Disassemble, clean, coat with grease, and reassemble.
Sleighs-----	Oil, engine-----	Keep clean and coated with oil.
Leveling mechanisms--	Grease, O. D.-----	Every 6 months. Clean and repack with grease.
Breech and firing mechanisms.	Oil, lubricating, preservative, light.	Daily.
Gun bores-----	Oil, lubricating, preservative, light.	After firing. Clean and oil. Daily. Inspect, clean, and oil if necessary.
Exposed, finished-metal surfaces.	Oil, engine-----	Keep clean and coated with light film of oil.

## SECTION VI

## DISASSEMBLY AND ASSEMBLY

	Paragraph
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Removal and installation of guns.....	27
Removal of breech mechanisms of mounted guns.....	28
Removal and installation of upper carriage.....	29
Removal and installation of recoil mechanism.....	30
Removal and installation of sleighs.....	31
Removal and installation of equilibrator.....	32
Removal and installation of equilibrator spiral springs.....	33
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Adjustment of firing mechanism.....	35
Removal and installation of electric generator.....	36
Installation of elevating mechanism.....	37
Installation of traversing mechanism.....	38
Adjusting brake blocks.....	39
Changing brake linings in gear-change mechanism.....	40
Changing brake linings in clamping mechanism for traversing mechanism...	41

**26. General.**—"Removal" is used in this section to denote removal of a *complete* unit. "Installation" is used in this section to denote installation of a *complete* unit.

**27. Removal and installation of guns** (figs. 11 and 14).—*a. General.*—(1) Carry out mounting and dismounting of guns with upper carriage in locked position.

(2) Carefully remove all dirt from the bearing surfaces.

(3) Before fitting the guns in position, tip up the right-hand dust cover.

(4) For guns mounted on the right side, keep dust cover tipped up until guns are firmly held in the sleighs.

*b. To remove.*—(1) Remove locking pin. Pull knob, swing crank arm, then remove retaining pins from trunnion holes.

(2) Swing out lock (thus releasing breech) and withdraw gun backward from the yoke-shaped recess of rear gun attachment.

*c. To install.*—(1) The right guns lie upside down on the cradle.

(2) Rest breech of gun in yoke-shaped recess of sleigh. (The lock secures the breech bolt in position.)

(3) Bring front part of gun into correct position.

(4) Swing back crank arm until locking pin engages in front gun attachment (the retaining pins of the front gun attachment will then enter the holes in the trunnions and the gun will be secured in position).

(5) Make sure guns do not have too much side play in their front attachments, and are not supported loosely in the rear.

**28. Removal of breech mechanisms of mounted guns.**—*a. Set guns for "continuous fire."*



b. Open covers.

c. (In the case of the left guns, keep cover open by inserting bent rod.) Insert rod-shaped front end of bent rod as far as it will go between gun casing and raised cover. (In the case of the right guns, let down opened cover until it reaches the stop.)

d. Withdraw breech mechanisms of the left guns upward and to the rear, of right guns downward and to the rear.

e. When fitting guns in place, see that the right guns lie on their backs. Insert breech mechanisms into these guns in the same way.

**29. Removal and installation of upper carriage** (figs. 10 and 13).—*a. To remove.*—Remove the 12 bolts and washers, and the clamping plates which hold the upper carriage in position. Lift upper carriage vertically so as not to damage or bur any parts of the mount.

*b. To install.*—(1) Before mounting the upper carriage and its rotating ring on the lower carriage, thoroughly clean bearing surfaces of upper and of lower carriage.

(2) Set down upper carriage on its mount as vertically and evenly as possible. (If the upper carriage is not level, it causes burs to form and thus prevents the even bedding-down of the two parts.)

(3) Firmly bolt rotating ring in position with the 12 bolts and the clamping plates, fastening nuts tight with washers.

**30. Removal and installation of recoil mechanism** (figs. 19 and 20).—*a. To remove.*—(1) Loosen retaining wire.

(2) Screw end nut from carrier tube at the back.

(3) Remove cotter pin and pull belt to the front.

(4) Remove recoil mechanism (from the side); when doing so, take care that upper left recoil mechanism is not removed until control rod has been detached from the bearing pedestal.

*b. To install.*—(1) With sleighs mounted in place, insert recoil mechanism from the side.

(2) Insert only upper left recoil mechanism before control rod is mounted.

(3) Secure each recoil gear in front with the bolt and nut secured by a cotter pin.

**31. Removal and installation of sleighs** (figs. 19, 20, and 25).—*a. To remove.*—(1) Remove recoil gears.

(2) Remove trigger bars with their cable pulleys.

(3) Remove pulley brackets only when removing the lower sleighs.

(4) Remove deflecting pulleys on the left side of cover and recoil operating cams from upper right and lower left side.

(5) Pull sleighs back.

*b. To install.*—(1) Insert sleighs from the back into guard rails.

(2) Reassemble detached parts.

**32. Removal and installation of equilibrator** (figs. 22 and 23).—*a. To remove.*—(1) Elevate to 90° and clamp or lock cradle in this position.

(2) Remove magazine rack.

(3) Pull leaf spring aside by hand (see fig. 24) and unhook T-piece of cable from cable pulley.

(4) Remove square protective cover and right cover from equilibrator housing.

(5) Withdraw cable through large opening in equilibrator housing.

*b. To install.*—(1) Elevate to 90° and clamp or lock the cradle in this position.

(2) Slacken the four bolts from the housing.

(3) With the aid of three bolts, press cover off equilibrator housing.

(4) Lift cover, leaving ball bearing on the shaft.

(5) Lay cable on the cam plate and secure end of cable with the nut.

(6) To suspend cable in cable pulley, unscrew cartridge rack from equilibrator housing.

(7) Guide T-piece into upper carriage and hook it onto cable pulley of right drum, so that the leaf spring (see fig. 24) prevents the cable from becoming unhooked from cable pulley.

(8) Place right cover over ball bearing and onto shaft end of cam plate, and screw it to equilibrator housing.

(9) With help of the nut, tighten cable so that difference caused by tolerances of spiral springs (+3°) is compensated. When screwed endpiece of wire cable allows no further adjustment, the nut should be taken off and the pinion set back on the cam plate.

(10) Close the adjusting opening in equilibrator housing by screwing on square protecting cover.

(11) Check operation of equilibrator for proper functioning.

**33. Removal and installation of equilibrator spiral springs** (figs. 22 and 23).—*a. To remove.*—(1) Elevate to 90° and clamp or lock cradle in this position.

(2) Remove bolts which secure auxiliary spring in equilibrator housing.

(3) After slackening bolts and nuts, pull cover off equilibrator housing (the ball bearing remains on the shaft, since it is a force fit on the shaft and a loose fit in the cover).

(4) Withdraw ball bearing from shaft.

(5) Remove washer from shaft.

(6) Remove the two spiral springs with their washers from shaft.

*b. To install.*—(1) Pass spiral springs through left opening in equilibrator housing and lay spiral springs in groove of shaft, inserting a washer between the springs.

(2) After inserting another washer, clamp outside washer to shaft (thus preventing the spiral spring device from moving sideways).

(3) Fix spiral springs in position on equilibrator housing by screwing in an auxiliary spring.

(4) Push ball bearing onto shaft end of spiral spring device.

(5) Slip left cover over ball bearing and screw it to equilibrator housing.

(6) See that teeth of gear wheel engage in the pinion.

(7) Check operation of equilibrator for proper functioning. The handwheel load should be between 6.6 and 8.8 pounds at the high speed position.

**34. Removal and installation of firing cables** (figs. 12 and 19 to 21, incl.).—*a. To remove.*—(1) Remove protecting boxes and platform halves.

(2) Remove guns.

(3) Loosen pull rods by means of the turnbuckles.

(4) Remove cables from ball bearings of trigger bars.

(5) Remove cables from pulleys.

(6) Remove cables from ball-and-socket holder of lower ball supports fitted on the cover.

*b. To install.*—(1) Connect cable pulleys in ball-and-socket holder of lower ball supports fitted on the cover.

(2) Attach cables to pulleys and hook their ends in ball bearings of trigger bars.

(3) See that inner cables 1 and 2 go to the upper trigger bars, and outer cables 3 and 4 to the lower.

(4) Tighten cables by means of turnbuckles on the pull rods.

(5) See paragraph 35 for adjustment.

**35. Adjustment of firing mechanism** (figs. 12 and 19 to 21, incl.).—*a.* Before adjusting the firing mechanism, recheck it.

*b.* Clamp firing device to the guns so that the distance from the middle of the buffer head to the lower edge of the roller, supported in the firing device, is 2.52 inches (64 mm). (This corresponds to a distance of 0.314 inch (8 mm) from the lower edge of the breech to the lower edge of the roller.)

*c.* Set the sleighs forward (initial position). In order to do this, push them forward by hand until they spring back.

*d.* Attach cables according to firing diagram (fig. 21). At the same time, the inner transmitting parts must lead to the upper guns, and the outer transmitting parts to the lower guns.

- e.* Adjust trigger bars so that firing device has no initial tension.
- f.* For the latter, shorten or lengthen trigger bars with turnbuckles until distance between trigger bars and rollers of firing device is about 0.04 inch (1 mm).<sup>13</sup> Adjust the two diametrically opposite guns so that they fire simultaneously, at all angles from  $-10^{\circ}$  to  $+100^{\circ}$ , for all settings of the sleighs within the maximum recoil of 3.46 inches (85 mm).
- g.* Remove gun covers and cock guns.
- h.* Press down one of the pedals slowly, at the same time pulling out interrupter levers (see fig. 11) of appropriate gun.
- i.* If the breeches of the guns are not released simultaneously, shorten, by means of the turnbuckle, the pull rod of the gun which is firing late.
- j.* Repeat the above process until the breech mechanisms are released simultaneously.
- k.* Adjust the other breech mechanisms.
- l.* To insure that both breech mechanisms are freed simultaneously, do not make the corrections by adjusting the firing device on the guns themselves, but by adjusting the pull rods, thus correcting the amount of pull on the cables. Note that the amount of clearance first adjusted between the roller in the firing device and the trigger bars may be nil; this means that the tolerance in the two guns has been adjusted correctly.
- m.* The trigger bars must never be put under an initial tension (by shortening the pull rods) when the rods are not extended.
- n.* When this adjustment has been made, observe the following precautions:
  - (1) When pedals are pressed down, raise or lower trigger bars enough to allow firing devices to function and butt against the stops in the guns.
  - (2) The double-holed capstan-headed screw acting as a stop for the trigger bars must not prevent functioning of the firing mechanism; that is, the clearance should be about 0.04 inch (1 mm). After making this setting, secure the screws with wire.
  - (3) The trigger bars raised or lowered by the pedals to the full extent must be approximately horizontal at  $0^{\circ}$ ; that is, they must be parallel with the axis of the bores at all angles of elevation.
  - (4) It must be possible to operate the pedals with the minimum expenditure of energy so that the target can be properly followed while the guns are being fired.

<sup>13</sup> In the types of quadruple mount first supplied, adjust the pull rods by turning the yoke heads.

(5) When the pedals are pressed down to a point where the trigger bars are felt to be meeting a strong resistance (beyond the "stop" point), the overload springs in the spring plunger cylinders should come into action.

(6) When the pressure of the foot is taken from the pedals, the trigger bars must immediately come back to their normal positions.

(7) Test recoil mechanisms when stripped, moving sleighs with the guns in position.

**36. Removal and installation of electric generator** (fig. 16).—*a. To remove.*—(1) Screw off cylindrical nuts and remove bolts.

(2) Remove cover from generator box.

(3) Withdraw inside (seeger) washer.

(4) Slacken terminals (cable connector screws).

*b. To install.*—To fit the generator in place, proceed in reverse order.

**37. Installation of elevating mechanism** (figs. 17 and 18).—*a. To assemble the stripped carriage, attach housing of elevating mechanism to rear plate of upper carriage. The correct meshing of the elevating pinion (H8) with the elevating arc (H9) is insured by inserting the dowel pins.*

*b. Move traversing mechanism on base plate until the pinion (S9) meshes with the gear teeth of the rotating ring.*

**38. Installation of traversing mechanism.**—*a. Attach traversing mechanism securely to base plate.*

*b. If it is necessary to take up backlash in the bevel gears of the traversing mechanism, insert a washer between them.*

**39. Adjusting brake blocks.**—As two types of handwheels are in use, the methods of adjusting both types are described.

*a. Handwheel, old pattern.*—(1) Remove (seeger) washer (for shafts) from bolts.

(2) Lift eccentric bushings from handwheel until teeth project from toes riveted to the handwheel.

(3) Turn eccentric bushings until worn brake linings are so placed that when the setting of the hand release knob is altered, the linings do not slip on the drums.

(4) Fix eccentric bushings in this position, and place external (seeger) washer on bolt.

*b. Handwheel, new pattern* (fig. 27).—(1) Adjust brake blocks (R4) by means of slotted setscrews (R9) screwed in the forks of the brake levers (R5). Proceed as follows:

(a) Slacken the three countersunk bolts (R16) and detach cover (R15) from handwheel.

(b) Slacken cylindrical bolts (R10) in slotted forks (R8) of brake levers (R5), thus releasing setscrews (R9).

(c) Turn setscrews until brake blocks (R4) engage in appropriate drum or clutch plate (R6) (that is, with no pressure on hand-release knob of change gear). This causes rollers (R13) of roller levers (R14) to lift approximately 0.02 inch (0.5 mm) from cam plate (R12).

(2) Test by hand to see whether both rollers (R13) of the slow gear can turn.

(3) After pressing in hand-release knob (R7) (so bringing the high-speed gear into action), the brake blocks for this motion should be adjusted as in (b), above.

(4) With brake blocks correctly adjusted, rollers (R13) must lift from cam plate (R12). The braking force must be sufficient to prevent brake linings (R3) from slipping on brake drum (R6) while the change-over from one gear to another is being made when the gun is being layed.

(5) When steps (1) through (4) above have been taken, tighten bolts (R10), thus causing the slits of yokes (R8) to clamp together and secure setscrews (R9).

(6) Secure cover (R15) in position again with hexagonal bolts (R16).

**40. Changing brake linings in gear-change mechanism.**—As two types of handwheels are in use, the methods of changing the linings in both types are described.

*a. Handwheel, old pattern.*—(1) If the brake linings have become too worn to adjust, detach the particular handwheel after unscrewing the four fillister head screws.

(2) Remove (seeger) washer (for shafts) from bolts.

(3) Withdraw bolts and eccentric bushings.

(4) Remove brake lever from handwheel.

(5) Knock rivet out of brake block and brake lever.

(6) Take brake block from brake lever.

(7) Change brake lining.

(8) Reattach brake block to brake lever with a rivet pin.

(9) After putting helical compression springs in position, assemble brake lever in reverse order.

(10) Before placing handwheel in position, put brake blocks in their bottom setting with eccentric bushings, thus enabling the brake blocks to be slipped on over the brake drums and preventing damage to the brake blocks.

(11) Screw handwheel firmly in place with fillister head screws.

(12) Adjust brake blocks by means of eccentric bushings.

*b. Handwheel, new pattern* (fig. 27).—(1) Slacken countersunk screws (R16).

(2) Remove cover (R15) from handwheel.



- (3) Unscrew cylindrical bolts (R10).
- (4) Unscrew slotted setscrews (R9). The brake linings (R3) will loosen the brake disks. (R6).
- (5) Unhook helical compression springs (R11) from roller levers (R14).
- (6) Remove (seeger) washer (for shafts R1) from pins (R2).
- (7) Withdraw pins (R2).
- (8) Remove complete brake lever unit from handwheel.
- (9) Separate brake blocks (R4) from brake levers (R5) by knocking out the rivets.
- (10) Change brake linings.
- (11) To assemble, proceed in reverse order. When assembling, take care to screw the setscrews tight when fitting the complete brake levers so that the brake linings (R3) can be moved past the brake drums without damage to the linings. Afterwards adjust the brake blocks.

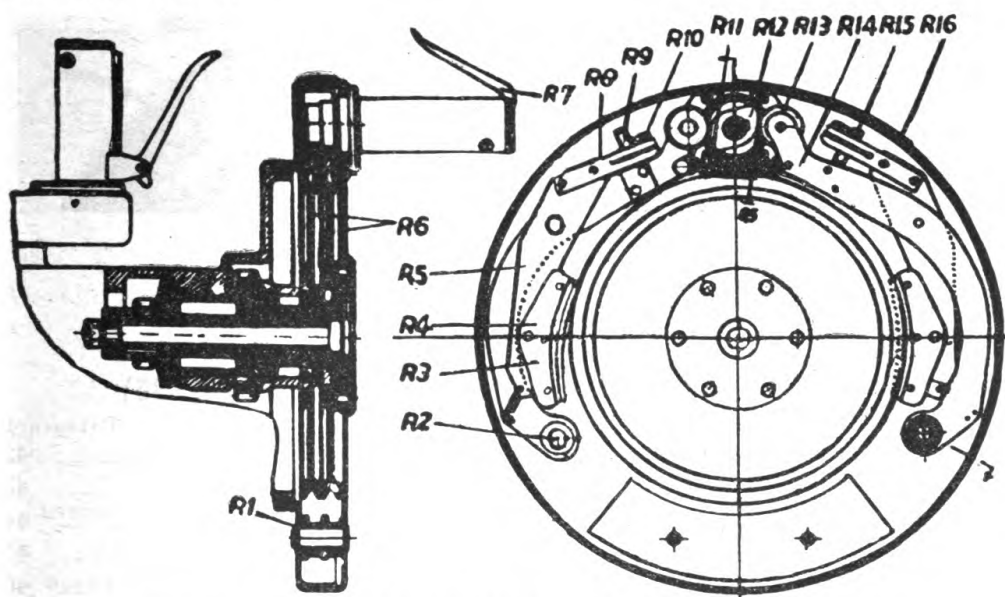


FIGURE 27.—Handwheel with change-over device—schematic diagram.

**41. Changing brake linings in clamping mechanism for traversing mechanism** (figs. 17 and 18).—*a.* Remove pin from handle of clamping gear and pull off handle.

*b.* After removing (seeger) washer, remove guide bushing with spindle from block guides.

*c.* Knock out pin and change brake blocks.

*d.* When the brake lining riveted inside the block guide is worn, the clamping arrangement, together with the shaft and the gears on the latter, must be removed. After knocking out the four counter-sunk rivets, change the lining.

*e.* Reassemble in reverse order.

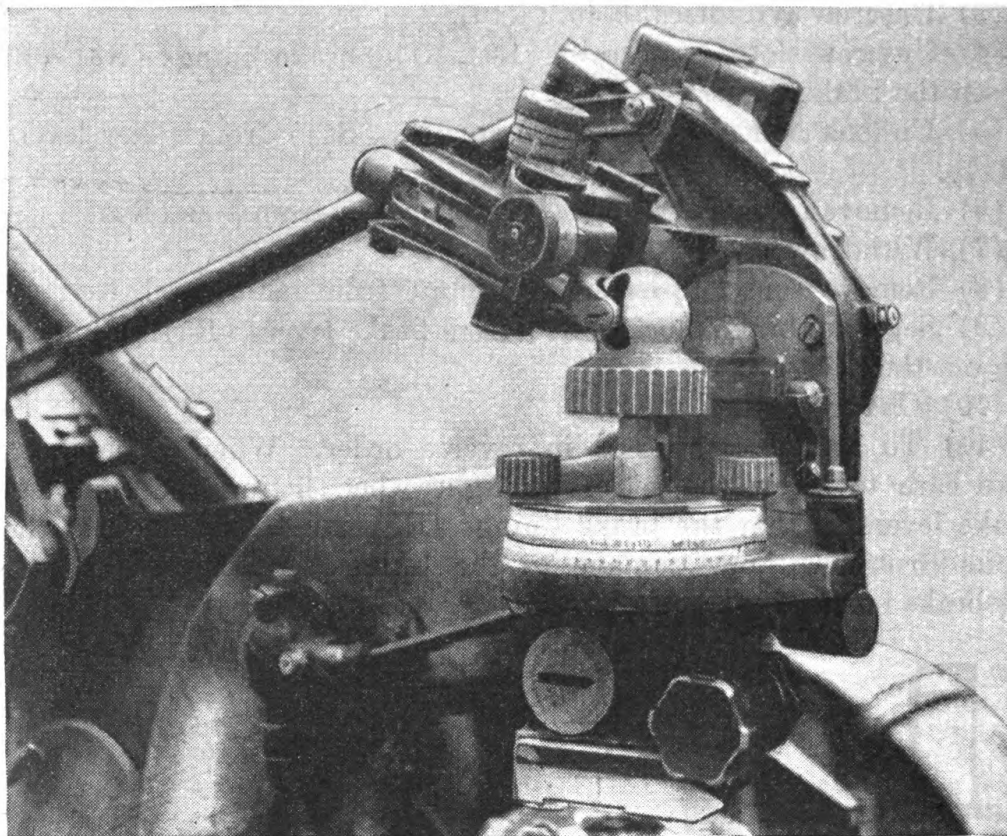


FIGURE 28.—Flakvisier 35.

## SECTION VII

## FLAKVISIER 35 (ANTIAIRCRAFT SIGHT 35)

	Paragraph
Characteristics and data-----	42
Theory-----	43
Description-----	44
Operation-----	45
Disassembly and assembly-----	46
Care and maintenance-----	47

**42. Characteristics and data.**—*a. Characteristics.*—Flakvisier 35 (antiaircraft sight 35) (figs. 28, 29, 34 to 39, incl., and 43 to 45, incl.) is the sight normally used against aerial targets with the 2-cm Flak 30 (sec. XII), but apparently may also be used with the 2-cm Flak 38 and the 2-cm Flakvierling 38.<sup>14</sup> Flakvisier 35 is a reflecting-

<sup>14</sup> Little is known at present concerning the exact details and operation of Flakvisier 40 (see fig. 16), which is designed for use with the 2-cm Flakvierling 38. But this new sight is believed to be similar in principle to Flakvisier 38, which is designed for use with the 2-cm Flak 38. Both of these sights may be fitted on sight head 38/40 (par. 5). For details on Flakvisier 38, see "German Antiaircraft Artillery," MIS Special Series, No. 10, par. 7b(2) (b).

mirror sight with a computer mechanism operating on the course-and-speed principle. It allows for the engagement of both climbing and diving targets, and is consequently very effective against a maneuvering target. It may also be employed for direct laying on fixed and moving land and sea targets, such as tanks and motor torpedo boats. Linealvisier 21 (linear sight 21) (sec. VIII) may be used as an alternative sight to Flakvisier 35. A telescopic sight (*Zielfernrohr*) is also fitted for engagement of ground targets (see fig. 16).

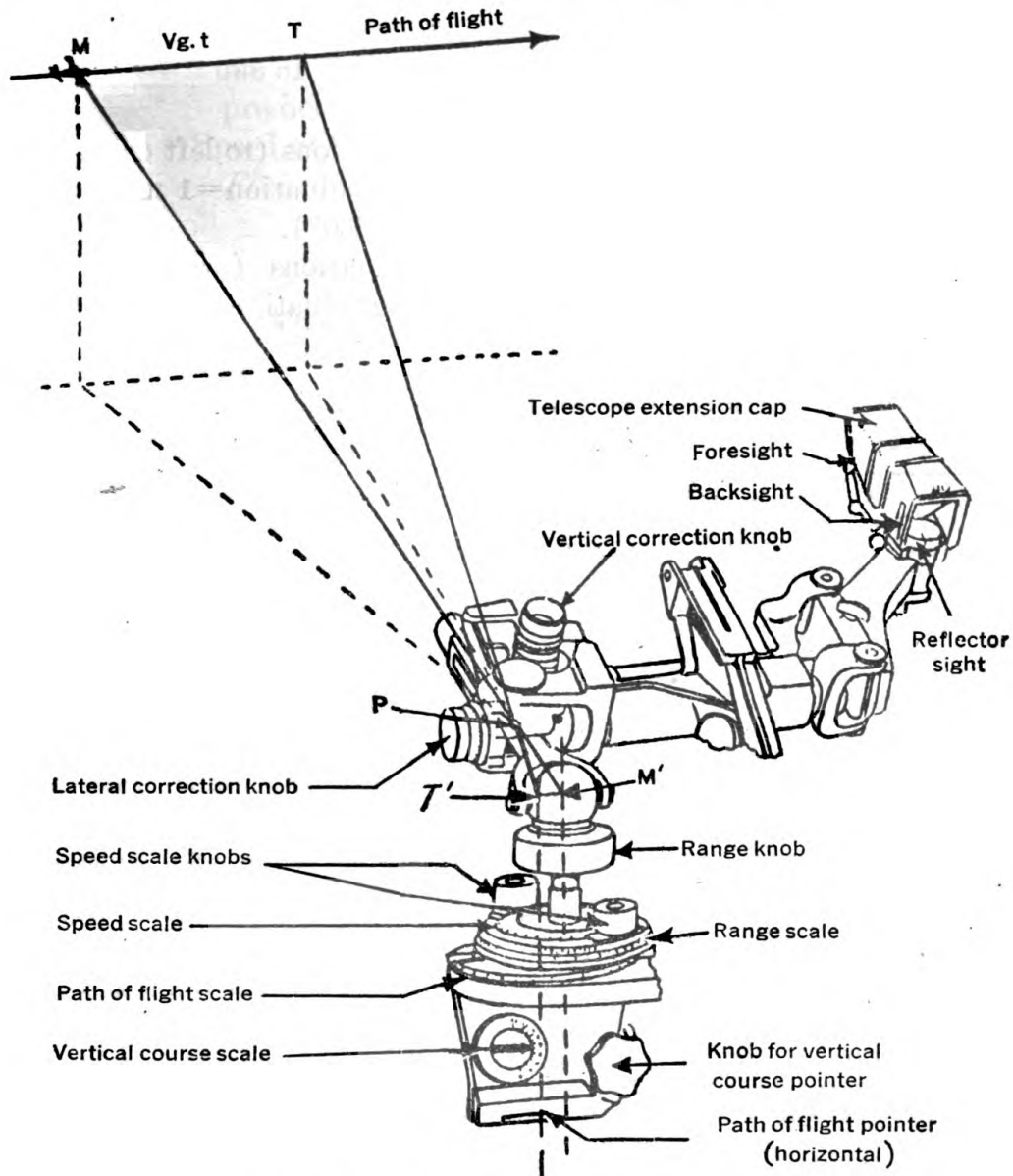


FIGURE 29.—Flakvisier 35—schematic diagram.

*b. Data.*

Speed of target----- 26 to 492 feet per second (18 to 335 miles per hour).  
 Range for antiaircraft fire-- 106 to 2,733 yards.  
 Range for land and sea targets. 0 to 2,950 yards.  
 Change of target height----- 60° dive from the horizontal, 20° climb from the horizontal.  
 Maximum depression of the gun. - 12°.  
 Maximum elevation of the gun. + 90°.  
 Lateral corrections----- 80 graduations (to left or right), each graduation=1 mil (6,400 mils=360°).  
 Vertical corrections----- 43 graduations (up or down), each graduation=1/16°=1.111 mils.

**43. Theory.**—(figs. 29 to 33, incl., and fig. 35).<sup>15</sup>—*a. Horizontal flight without superelevation* (figs. 29 and 30).—In figure 30 the

<sup>15</sup> The German symbols used in paragraph 43 do not conform to U. S. practice (see FM 4-155, table E, pp. 19-22), but no difficulty should result. Any German manual on antiaircraft or field artillery firing will use technical terms to describe the various firing angles, the principal vertical ones of which are illustrated in figure 33. Listed below are some of the terms employed in U. S., British, and German discussions of the subject:

<i>Angle (in fig. 33)</i>	<i>U. S.</i>	<i>British</i>	<i>German</i>
<i>a</i> -----	<i>Jump</i> -----	<i>Jump</i> -----	<i>Abgangsfehlerwinkel</i>
(Jump is the angle between the axis of the bore when the piece is laid and the line of departure. Its component in a vertical plane is called a <i>vertical jump</i> , and its component in a horizontal plane is called a <i>lateral jump</i> . In U. S. firing tables <i>quadrant elevation</i> includes the effect of vertical jump, and <i>drift</i> ( <i>Seitenabweichung</i> ) includes the effect of lateral jump.)			
<i>b</i> -----	<i>Superelevation</i> -----	<i>Tangent elevation</i> -----	<i>Auftatzwinkel</i>
(Superelevation is the angle between the axis of the bore when the piece is laid and the line of site. Superelevation is the term principally used in antiaircraft firing; the U. S. field artillery employs the term <i>elevation</i> .)			
<i>c</i> -----	<i>Angle of site</i> -----	<i>Angle of sight</i> -----	<i>Geländewinkel</i>
(The <i>angle of site</i> , which is sometimes called <i>position angle</i> , is the angle between the line of site and the horizontal. The <i>line of site</i> is a straight line connecting the origin, usually a gun or a position-finding instrument, with a point. The <i>line of sight</i> is a line of vision: that is, the optical axis of an observation instrument. Obviously, on occasion the line of <i>site</i> may also be the line of <i>sight</i> .)			
<i>d</i> -----	<i>Angle of departure</i> -----	<i>Angle of projection</i> -----	<i>Schusswinkel</i>
(The <i>angle of departure</i> is the angle between the line of departure and the line of site.)			
<i>e</i> -----	<i>Quadrant elevation</i> -----	<i>Quadrant elevation</i> -----	<i>Erhöhungswinkel</i>
(Quadrant elevation is the angle between the axis of the bore when the gun is laid and the horizontal.)			
<i>f</i> -----	<i>Quadrant angle of departure</i> -----	<i>Angle of departure</i> -----	<i>Abgangswinkel</i>
(Quadrant angle of departure is the angle between the axis of the bore when the projectile leaves the gun and the horizontal.)			

predicted triangle  $PMT$  in space is reproduced in the sighting apparatus by the triangle  $PM'T'$ . In the triangle  $PMT$ —

$P$  = Position of the gun (*Geschütznullpunkt*).

$M$  = Position of the target at the instant of firing (present position) (*Messpunkt*).

$T$  = Predicted (future) position (*Treffpunkt*) of the target.

$M$  = Slant range to the target at the instant of firing (present position) (*Messentfernung*).

$T$  = Slant range to the target at its predicted (future) position (*Treffpunktentfernung*).

$t$  = Time of flight of the projectile (*Geschossflugzeit*) to the predicted (future) position of the target.

$Vg$  = Speed of the target along its path (*Geschwindigkeit des Flugzieles*).

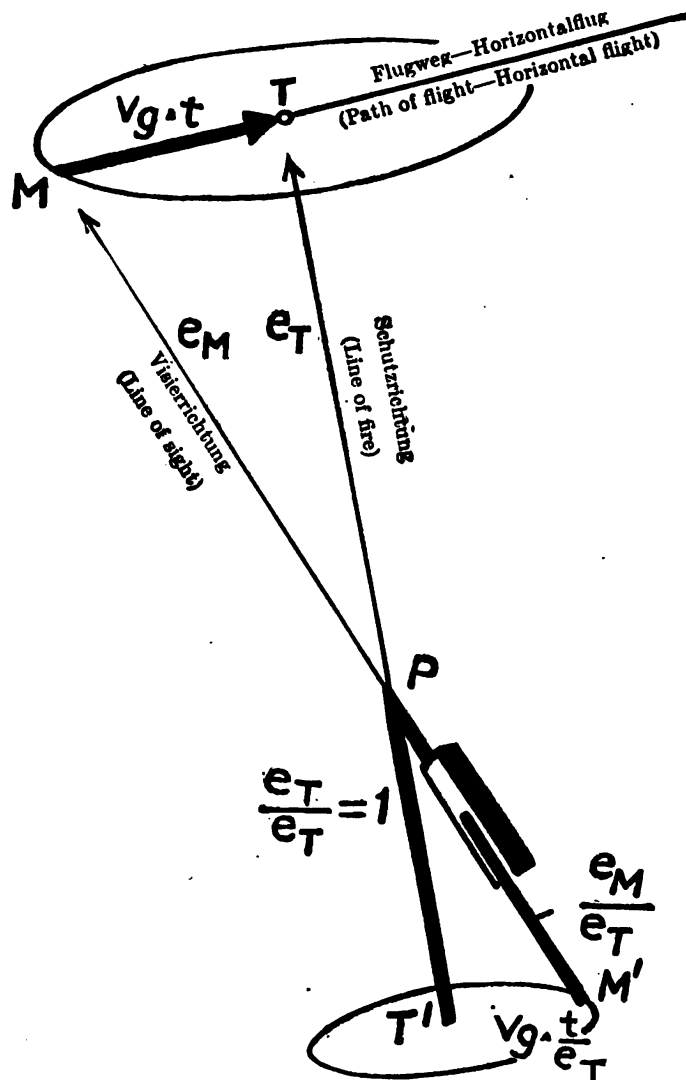


FIGURE 30.—Horizontal flight without superelevation.

$Vg.t$  = Distance traveled by the target during the time of flight of the projectile (*Hauptauswanderungstrecke*).

In the triangle  $PM'T'$  reproduced in the sighting apparatus (fig. 29; see also fig. 35)—

$P$  = Fixed point of the weapon which rotates around the horizontal axis passing through the center ( $T'$ ) of the computer box, determining the elevation to be given to the gun barrel.

$T'$  = Center of the computer box.

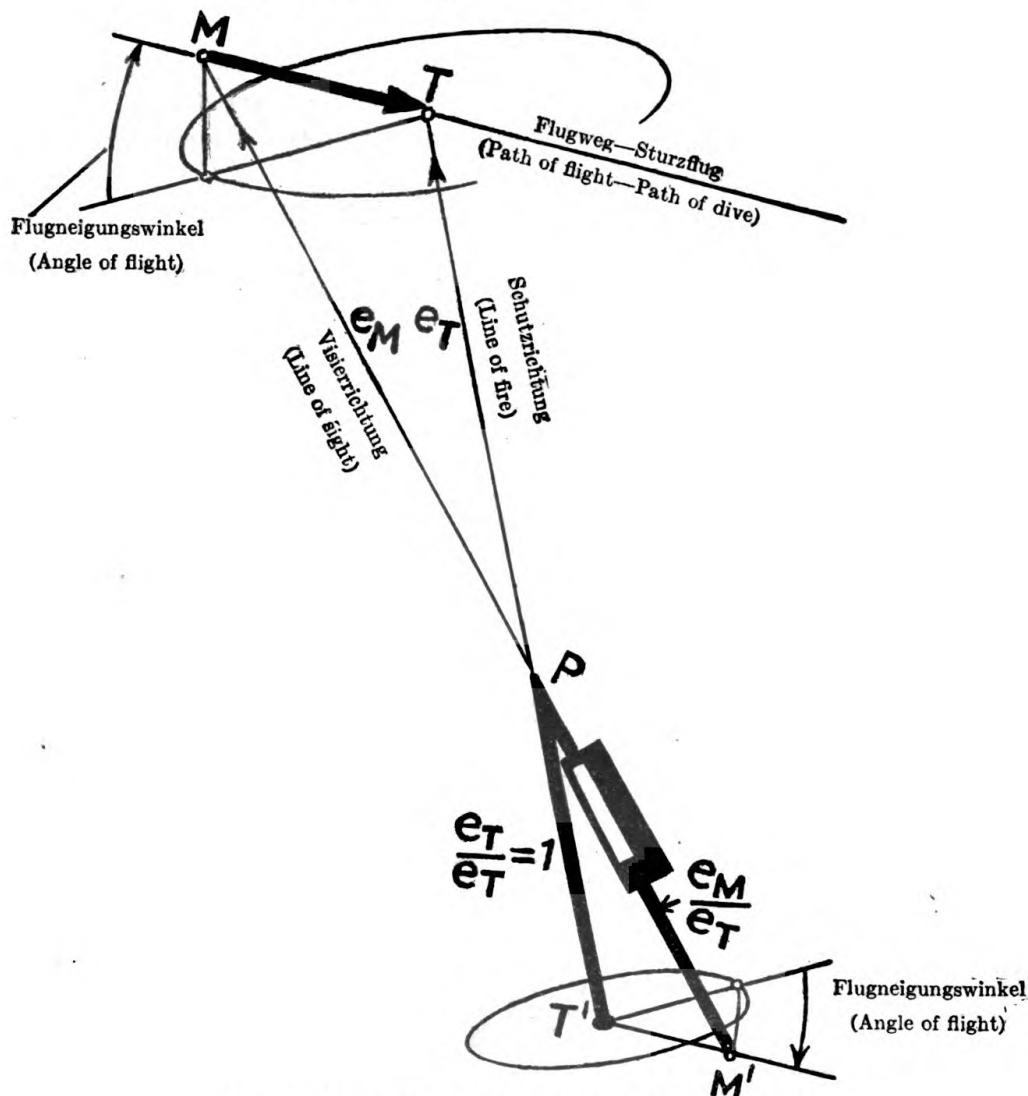


FIGURE 31.—Angle of flight without superelevation.

The predicted triangle  $PMT$  is reproduced by the triangle  $PM'T'$  on a scale of  $1:e_T$ , so that the side  $PT' = \frac{e_T}{e_T} = 1$ , and therefore remains constant, while the side  $PM' = \frac{e_M}{e_T}$  and the side  $M'T' = \frac{t}{e_T} \times Vg$ .



$Vg$  is estimated by the gun commander to the nearest 20 miles per hour, and is set (see fig. 37) on the speed scale (29) of the computer box by the two knobs (24).

$^eT$  (slant range to future position) is obtained by dividing  $^eM$  (present slant range) by  $\frac{^eM}{^eT}$ .

$\frac{^eM}{^eT}$  is the side  $PM'$  of the triangle  $PM'T'$ ,  $^eM$  is measured by the range finder, and  $t$  (time of flight of projectile) can be found if  $^eT$

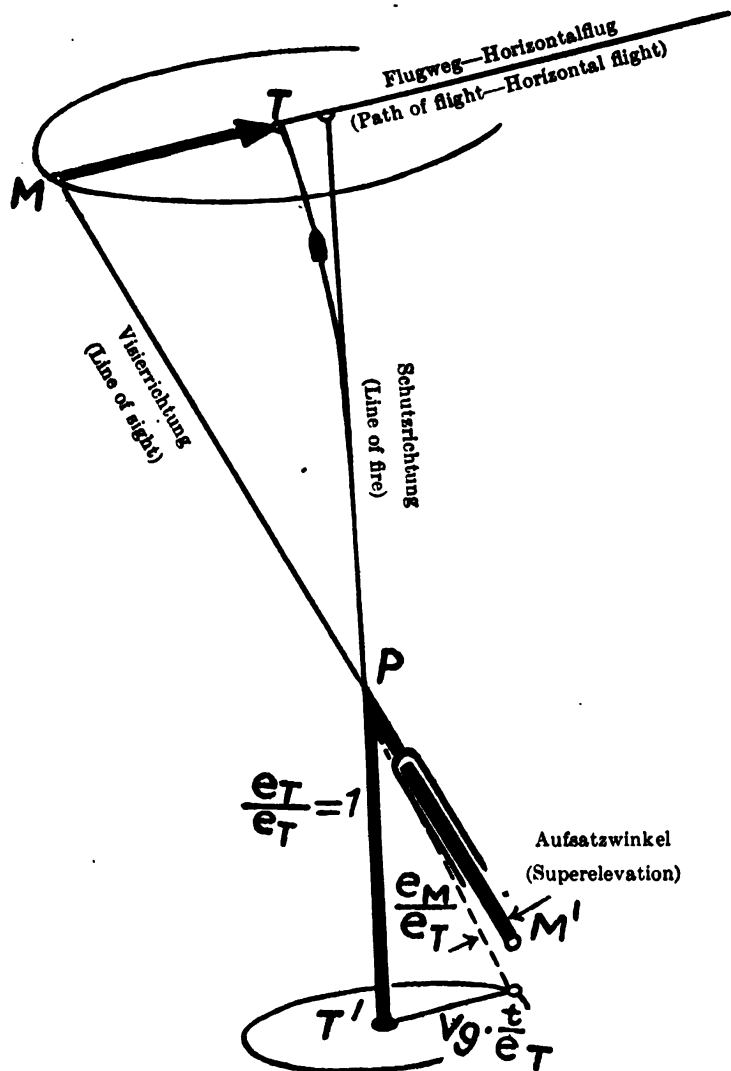


FIGURE 32.—Horizontal flight with superelevation.

(slant range to future position) is known. Therefore,  $\frac{t}{^eT}$  can be calculated and applied to the computer box by setting, not  $\frac{t}{^eT}$ , but  $^eM$  (present slant range) onto the range scale in the computer box. This

is done by turning the range knob (25) until the correct colored arrow (27) is opposite the range ordered on the range scale (28). The correct color to use for any given range is shown (see fig. 35) by the index (15) on the series of colored fields (14). This operation, in fact, sets in the slant range to the future position ( ${}^eT$ ) and displaces the point  $M'$  to an amount corresponding to  $\frac{t}{eT}$ .

*b. Diving or climbing flight without superelevation (fig. 31).—*For diving or climbing targets the path  $M'T'$  must be set parallel to the line of flight ( $MT$ ). This is done by lowering or raising point  $M'$ . No allowance need be made for increased or reduced speed of the target.

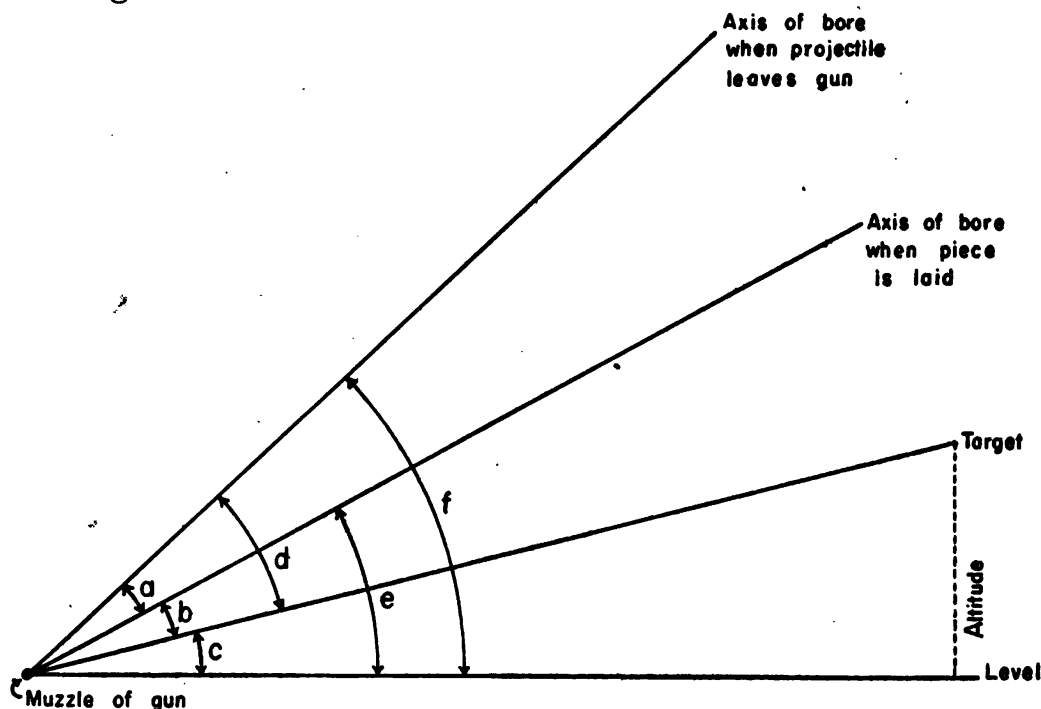
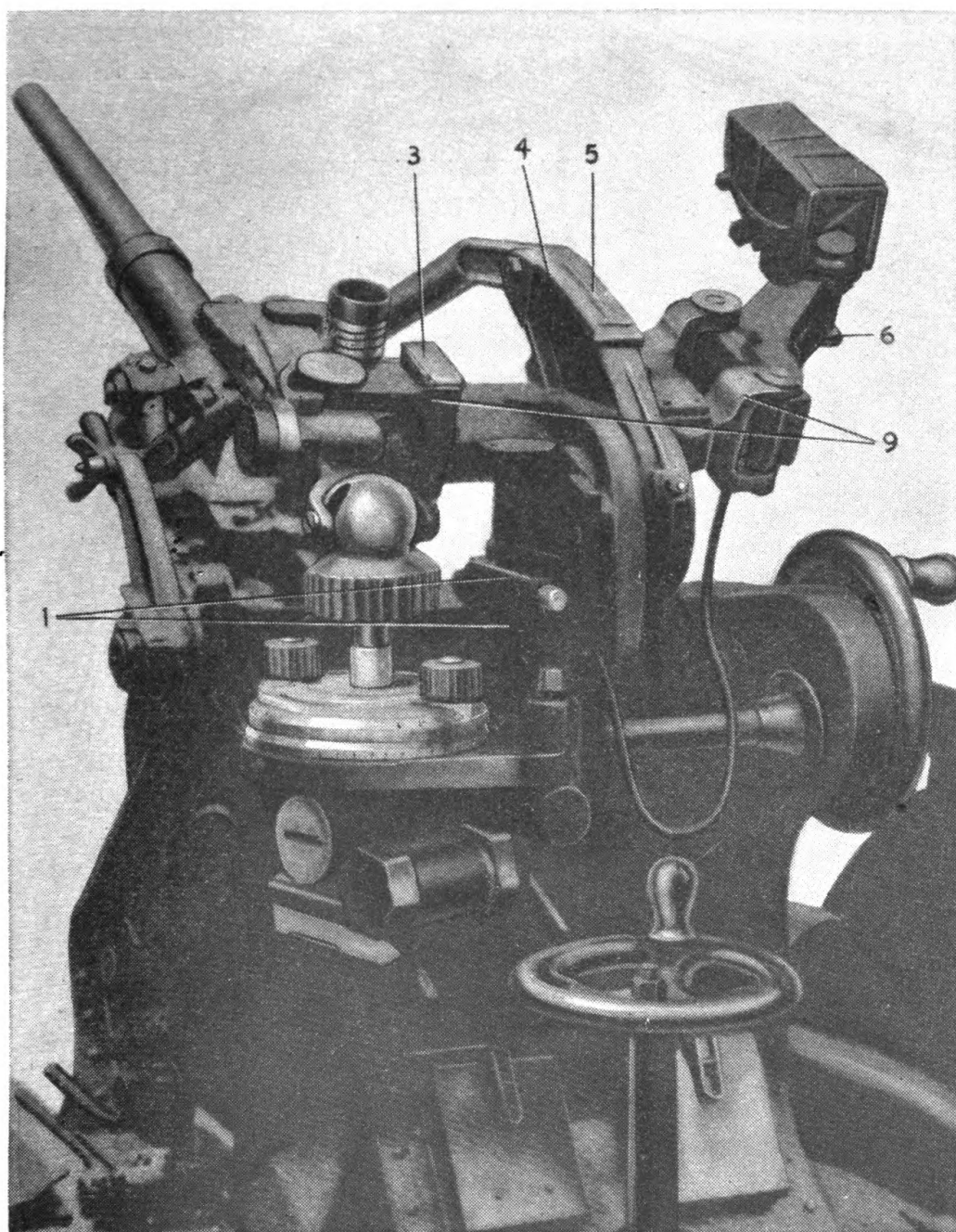


FIGURE 33.—Schematic diagram of vertical firing angles.

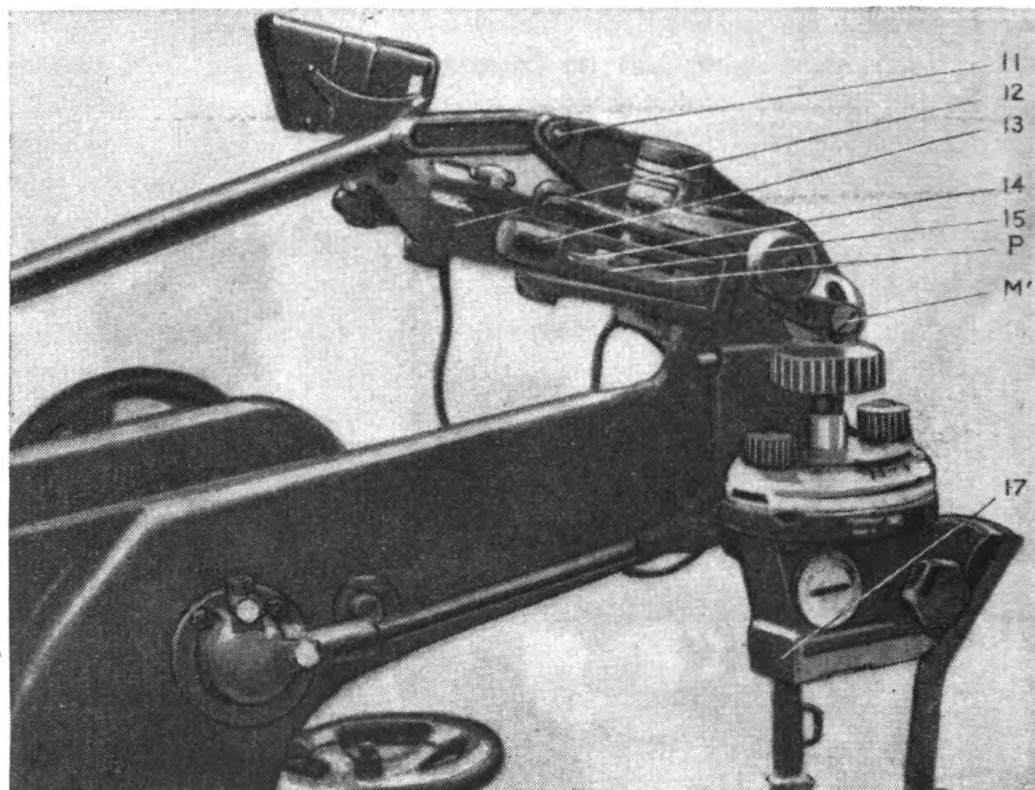
*c. Effect of superelevation (fig. 32).—*It will be observed that no account has been taken of superelevation in figures 29, 30, and 31. The effect of superelevation with horizontal flight is shown in figure 32. Naturally this consideration also applies to climbing or diving targets (fig. 31). Allowance for superelevation is made by raising point  $M'$  vertically above the line of sight by an amount equal to the superelevation required in horizontal firing. The instrument admits of no alteration in superelevation for an increase in the angle of site.



- 1. Bracket.
- 3. Clinometer plane.
- 4. Elevation arm.

- 5. Elevation arm plane.
- 6. Setscrew.
- 9. Coupling member.

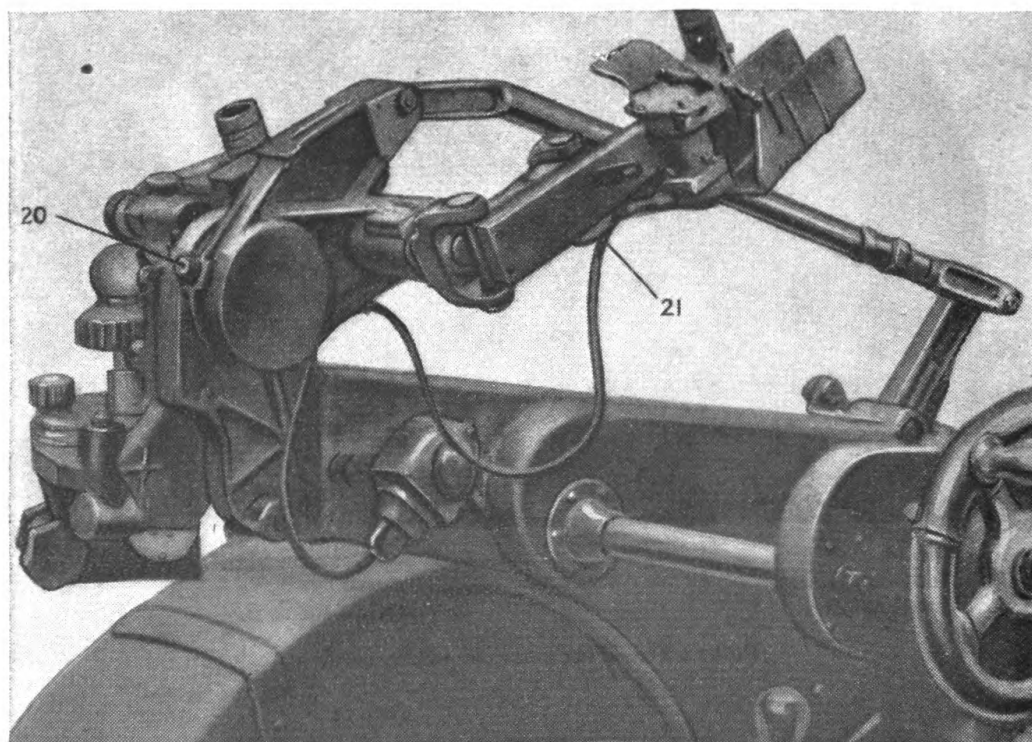
FIGURE 34.—Flakvisier 35—rear view.



11. Connecting pin.  
12. Parallelogram system.  
13. Plunger cylinder.

14. Colored fields.  
15. Index or pointer.  
17. Hand grip for setting target direction.

FIGURE 35.—Flakvisier 35—left side view.



20. Lubrication point.

21. Electric wire.

FIGURE 36.—Flakvisier 35 with reflector sight in place—right rear side view.

**44. Description.**—*a. General.*—Flakvisier 35 consists of the following three main parts: the computer box, the elevation arm, and the reflector sight. The computer box, which is mounted horizontally on the carriage, reproduces the target course on a reduced scale ( $T'M'$ ). The point  $M'$  of the computer box (figs. 29 and 35) is coupled by means of a universal joint (fig. 37①) to the plunger (26) of the reflector sight. The elevation arm ( $T'P$ ) and parallelogram system (fig. 29) transfer the line of sight ( $M'P$ ) to the reflector sight.

*b. Computer box* (fig. 37).—The computer box consists of the following:

(1) Two knobs (24), for setting target speed on the speed scale (29). This scale is graduated from 0 to 150 meters per second (0 to 335 miles per hour).

(2) Range knob (25), by means of which the appropriate colored arrow (27) is matched with the range ordered on the range scale (28).

(3) Hand grip (17), which is used for setting the mechanism parallel to the horizontal course of the target (fig. 35). A spring-loaded hinge (31) provides a quick release for this hand grip.

(4) Knobs (30), for setting the vertical course pointer (23) parallel to the vertical course of the target on one of two graduated scales (22).

(5) Square shaft extensions (34 and 35), which are part of the return drive mechanism (fig. 37②). One of these is coupled to the traversing mechanism of the weapon in such a way that the hand grip turns through the same angle but in the opposite direction to the gun. This means that there is no need to continue turning the hand grip after the mechanism has once been brought parallel to the horizontal line of flight, unless and until the target changes course.

(6) Two trunnions (33) and locating key (36), which keep the computer box in position.

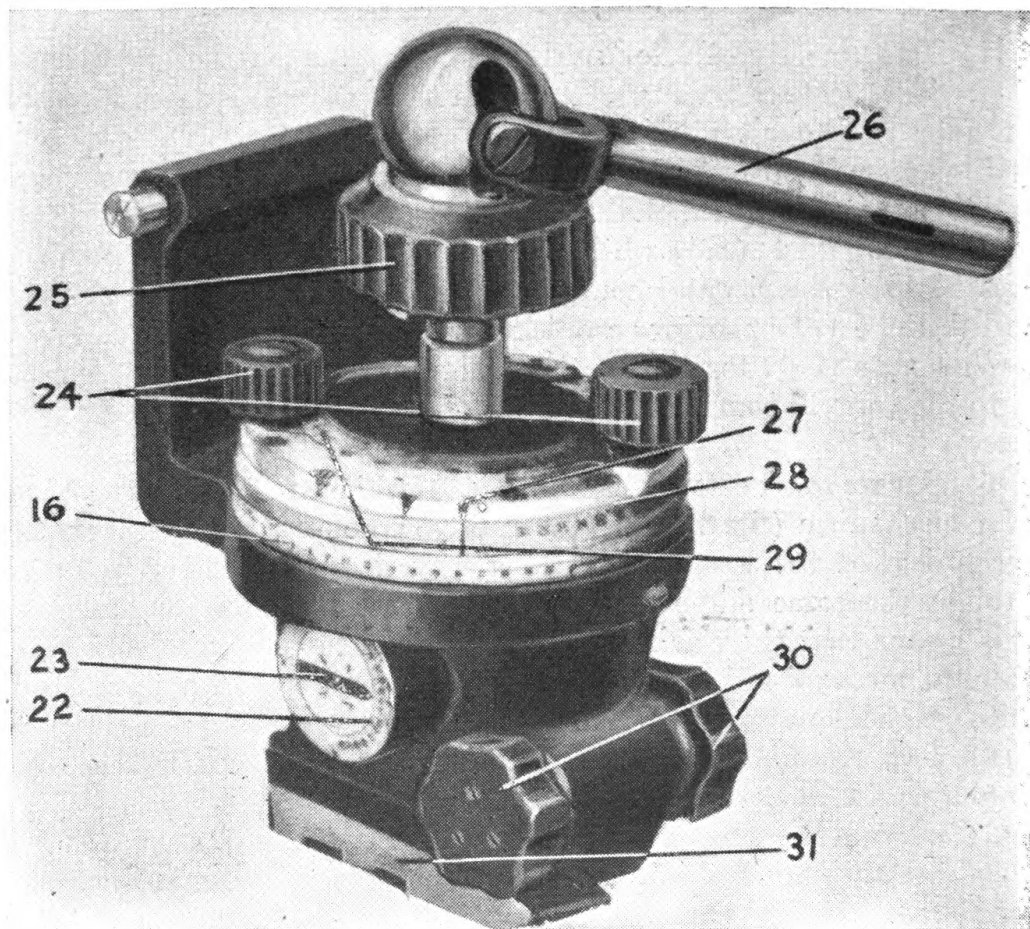
*c. Elevation arm* (figs. 29 and 34 to 39, incl.).—Elevation arm ( $T'P$ ) (4) moves through the same angle as the gun barrel around the horizontal axis passing through point  $T'$  of the computer box. The coupling member (9) rotates in the horizontal sleeve the axis of which passes through  $P$ . On the left of this is a plunger cylinder (13) mounted on a universal joint in which enters a plunger (26), itself coupled to point  $M'$  of the computer box. The plunger cylinder is therefore always laid along the line of sight ( $M'P$ ). On the right side of the coupling member (9), connected to the universal joint and vertically parallel to plunger cylinder (13), is an undercut groove (50) into which the reflector sight fits. This groove is also kept horizontally parallel to the cylinder (13) by the parallelogram system (12). When the vertical correction scale (42) is at zero, this plane (3) is



parallel to the elevation arm plane (5). The elevation arm (4) consists of the following:

(1) Elevating arm plane (5), which must be kept parallel to the axis of the bore of the gun. A hinged cover is provided for protection.

(2) Connecting pin (11), which is coupled to the guide bar on the gun barrel, and keeps the plane (5) parallel to the bore of the gun whatever the elevation.



16. Path of flight scale.  
22. Vertical course scale.  
23. Vertical course pointer.  
24. Speed scale knobs.  
25. Range knob.  
26. Plunger.

27. Colored arrow.  
28. Range scale.  
29. Speed scale.  
30. Knobs for vertical course pointer.  
31. Hinge.

① Left front view.

FIGURE 37.—Computer box of Flakvisier 35.

(3) Elevation arm lubrication point (20).

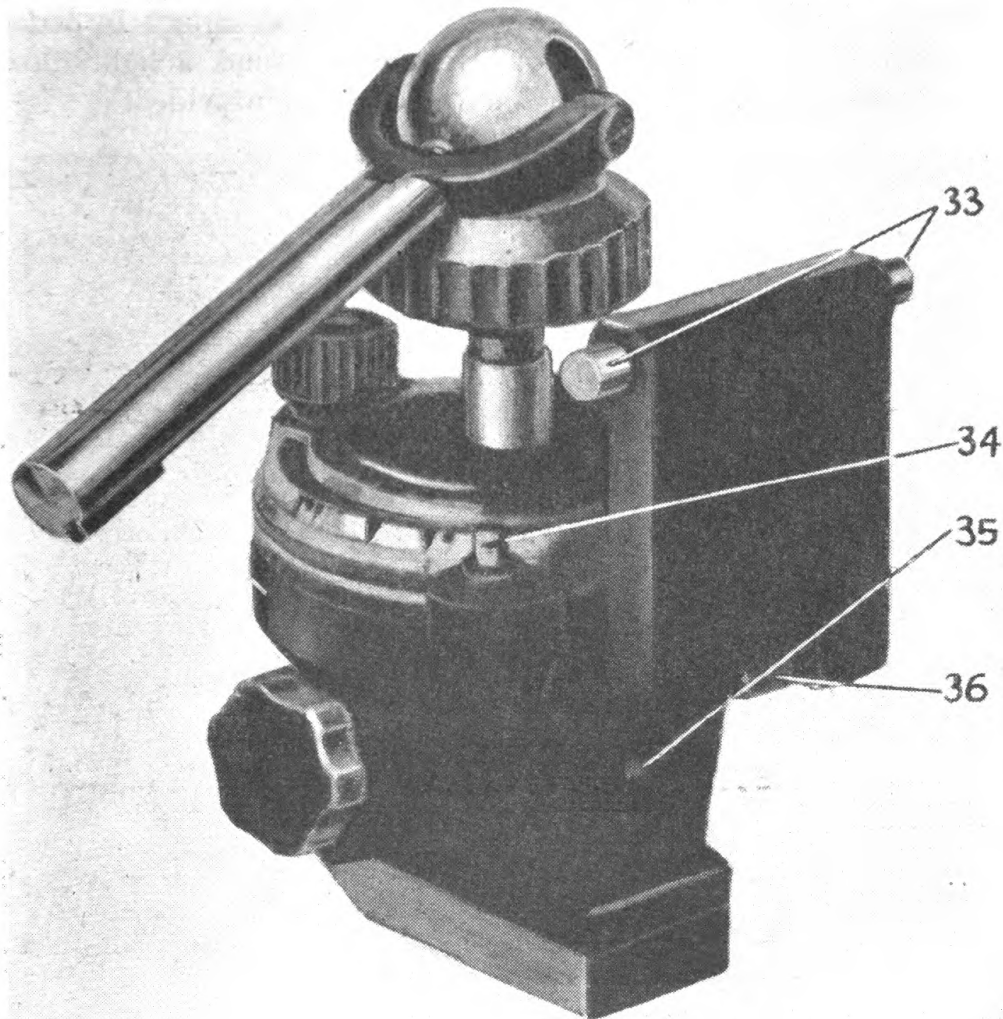
(4) Coupling member (9), which includes the following:

(a) Clinometer plane (3), vertically paralleled to the grove (50) and line of sight of the reflector sight.



(b) Lateral correction knob (46), for making corrections in azimuth from observation of tracer, on the scale (45).

(c) Vertical correction knob (43), for making elevation corrections from observation of tracer, on the scale (42). For use against



33. Trunnions for computer box.

36. Locating key for computer box.

34. } Square drive extensions for return  
35. } drive mechanism.

② Right rear view.

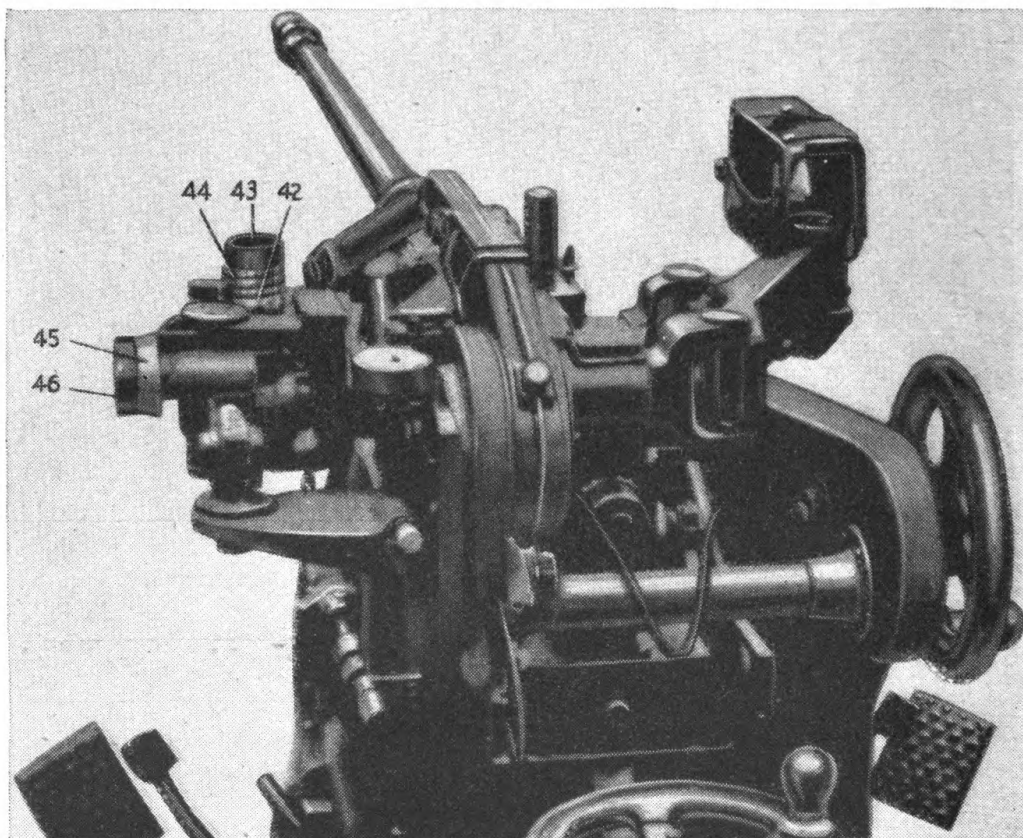
FIGURE 37.—Computer box of Flakvisier 35—Continued.

land or sea targets this knob is used to make corrections from observation of fire, on the scale (44).

(d) Pointer (15), for the series of colored fields (14). This indicates the correct color for any range ordered (see par. 43a).

*d. Reflector sight* (figs. 36, 40, and 41).—The reflector sight may be used for both day and night shooting. It consists of the following:

(1) Illuminated optical sight, in which a reflector throws a cross on the object glass (53), which is set at an angle of  $45^\circ$ . The layer keeps this cross and the target coincident. Illumination is provided by a flashlight bulb (66) ("Osram" 3.8 volts—0.3 amperes) connected by an electric wire (21) to a battery. Should this fail during the day, it is still possible to use the optical sight. In order to improve vision when there is a bright background, a light filter (54), which is secured by means of a knob (70), is provided.



- |   |                               |
|---|-------------------------------|
| 42. Vertical correction scale (for tracer observation). | 45. Lateral correction scale. |
| 43. Vertical correction knob.                           | 46. Lateral correction knob.  |
| 44. Vertical correction scale (for fire observation).   |                               |

FIGURE 38.—Flakvisier 35 in position—rear view.

(2) Normal open sight (55 and 56), for use in the event of failure of electric current.

(3) Weatherproof cover (58). For cleaning, the cover may be removed by depressing the two springs (60). If it is desired to sight the gun without the weatherproof cover, the cover should be lifted and the two spring catches (59) pulled until they come out of their sockets. The shutter (57) must be opened to sight the gun by day when the cover is in place.

**45. Operation** (figs. 35, 37, 38, and 40).—*a. Preparation.*—(1) Switch on reflector sight lighting.

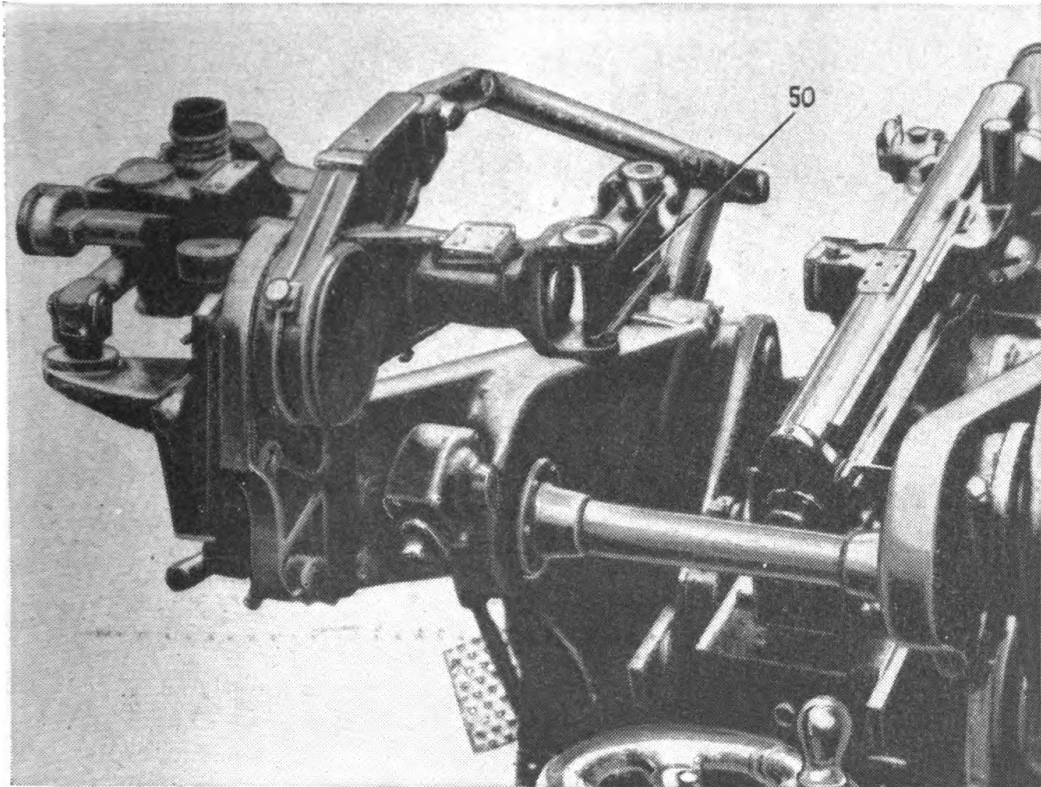
(2) Insert light filter (54), if required.

(3) Put on weatherproof cover (58), if wet.

*b. Tests before firing.*—(1) Test the line of sight on a distant target.

(2) It is not necessary to insert the sight-testing apparatus into the upper left-hand gun.

(3) Level carriage until it is horizontal.



50. Undercut groove for reflector sight.

FIGURE 39.—Flakvisier 35 without reflector sight—rear right side view.

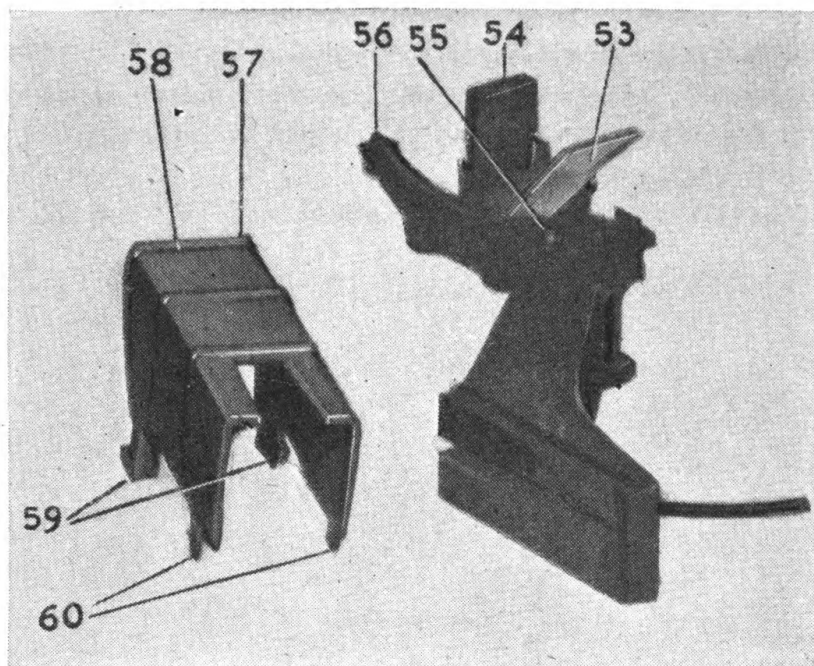
(4) Attach sight head.

(5) Correct line of sight.

(6) Test by laying gun on a distant object (the top of a tree, a church steeple, etc.) at a range of at least 1,000 yards. The line of sight should now coincide with the target on which the gun is layed.

(7) In the case of deviations, lateral or vertical, correct luminous mark in reflecting sight by turning vertical and lateral angle corrector knobs in relation to the target.

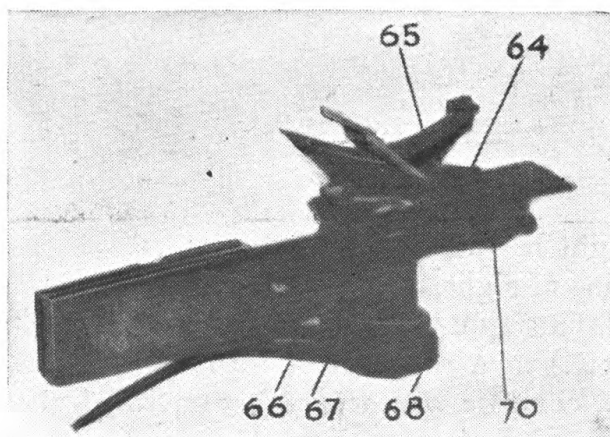
(8) Set appropriate scale rings to zero by screwing the three screws at the top of the knobs, and then tighten screws.



53. Object glass.  
54. Light filter.  
55. } Open sights.  
56. }

57. Shutter.  
58. Cover  
59. Spring catches.  
60. Springs.

FIGURE 40.—Reflector sight of Flakvisier 35—left rear side view.



64. Glass holder.  
65. Glass holder.  
66. Bulb holder.

67. Bulb holder nut.  
68. Focusing knob.  
70. Light filter knob.

FIGURE 41.—Reflector sight of Flakvisier 35—right side view.



(9) Follow a similar procedure for the telescopic sight. Adjustments are made by shifting corrector screws under the telescope.

*c. Operations.*—(1) Keep cross on object glass and target coincident.

(2) Set speed of target on speed scale (29) with one of the two knobs (24).

(3) Bring mechanism parallel to course of target by means of hand grip (17). Once this is done, the sight is automatically kept parallel to the course of the target by the return drive mechanism, provided the target does not change course.

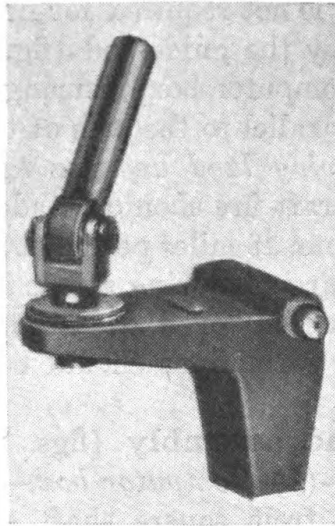


FIGURE 42.—Guide rod for Flakvisier 35.

(4) Set vertical course pointer (23) parallel to vertical course of target on one of the two scales (22).

(5) Bring appropriate colored arrow (27) opposite range ordered on scale (28). (The correct color to use is directed by pointer (15) on colored field (14).)

(6) The gun is now ready to fire.

*d. Corrections from observations of tracer.*—Corrections must be made on the assumption that the layer has maintained coincidence.

(1) *Target speed.*—If the tracer is in front of or behind the target, a different target speed must be set in on the scale.

(2) *Target course.*—If the tracer is high or low, or to the left or right of the target, range, being obtained from the range finder, is assumed to be correct. Lateral corrections are applied to lateral correction scale (45) by means of knob (46); vertical corrections, to vertical correction scale (42) by means of knob (43).

*e. Engagement of fixed land and sea targets.*—(1) Set speed scale (29) to zero.

(2) Set range scale to zero.

(3) Set vertical course pointer (23) to zero.

(4) Set lateral correction scale (45) to zero.

(5) Set range ordered on fixed target range scale (44) by means of knob (43).

(6) Sight gun on target.

(7) The gun is now ready to fire.

(8) Corrections for range from observation of fire are applied to range scale (44).

(9) The computer box is not required for fire against fixed targets and should be replaced by the guide rod (fig. 42). This is mounted in the same way as the computer box, insuring that the line of sight of the reflector sight is parallel to the axis of the bore of the gun.

*f. Engagement of moving land and sea targets.*—(1) The same procedure as for antiaircraft fire should be adopted for land and sea targets moving at more than 18 miles per hour.

(2) For land and sea targets moving at less than 18 miles per hour, the procedure is the same as for fixed targets, with the exception that vertical and lateral corrections should be applied as necessary from observation of fire.

**46. Disassembly and assembly** (figs. 34, 35, and 37 to 39, incl.).—*a. Disassembly.*—(1) *Computer box.*—Release connection of return drive mechanism from square shaft extensions (34 or 35). Loosen holding-down screw, tilt stop sideways, and lift computer box off its bracket (1), at the same time withdrawing plunger (26) from plunger cylinder (13).

(2) *Reflector sight.*—Disconnect the electric wire, loosen setscrew (6), and draw reflector sight out of its groove.

*b. Assembly.*—(1) *Computer box.*—Set vertical and lateral correction scales, as well as the vertical course scale, at zero. Insert plunger (26) into plunger cylinder (13). Fit computer box to its bracket (1) by means of the two trunnions (33), at the same time engaging locating key (36) in its slot. Insert stop and tighten screw. Connect square shaft extension (34 or 35) to return drive mechanism.

(2) *Reflector sight.*—Loosen setscrew (6), slide reflector sight into its undercut groove (50), retighten screw, and plug in the wire.

**47. Care and maintenance** (figs. 34, 35, and 40 to 43, incl.).—*a. Handling.*—Flakvisier 35 must be handled with care, particularly the moving parts of the parallelogram system. These should be kept well oiled with oil, engine. Flakvisier 35 is able to withstand normal



wear and tear but must not be unduly bumped and jolted during assembly and transport. For transport, the various parts of the reflector sight must be packed in their case (fig. 43).

*b. Cleaning optical parts.*—The object glass (53) and the light filter (54) should be wiped from time to time with lens tissue paper. They can be reached by opening weatherproof cover (58).

*c. Changing glass plates.*—These are removed by loosening the screws on their respective holders (64 and 65).

*d. Changing bulb.*—Unscrew nut (67) and remove bulb holder (66) and cable. When the new bulb has been inserted, focus by means of knob (68).

*e. Lubrication.*—(1) The bearing of the elevation arm (4) should be lubricated periodically at the point (20) with grease, O. D., No. 0, above  $+32^{\circ}$  F., and No. 00, below  $+32^{\circ}$  F.

(2) Oil metal surfaces with oil, engine, SAE 30, above  $+32^{\circ}$  F., and SAE 10, below  $+32^{\circ}$  F.

(3) Do not apply oil to electric wiring.

(4) Do not allow oil to remain on scales or optical parts.

*f. Packing.*—When not in use, and, above all, in transport, the computer box and reflector sight should be packed in their case (fig. 43). The computer box should then be replaced by the guide rod (fig. 42).

*g. Spare parts and accessories.*—(1) *Spare parts.*—The spare parts consist of the following:

2 object glasses.

2 light filters.

4 bulbs ("Osram" 3.8 volts—0.3 amperes).

1 bulb holder (with bulb).

1 cable about 2 feet long.

1 plug.

(2) *Accessories.*—The accessories consist of the following:

1 screw driver.

1 0.098-inch (2.5-mm) watchmaker's screw driver.

1 soft cleaning cloth.

1 bristle brush.

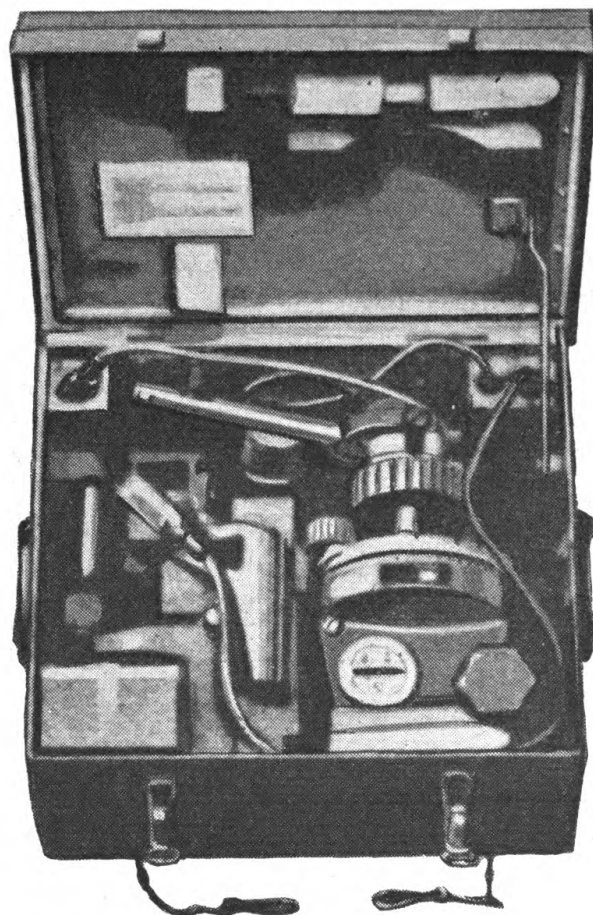


FIGURE 43.—Flakvisier 35 in packing chest.

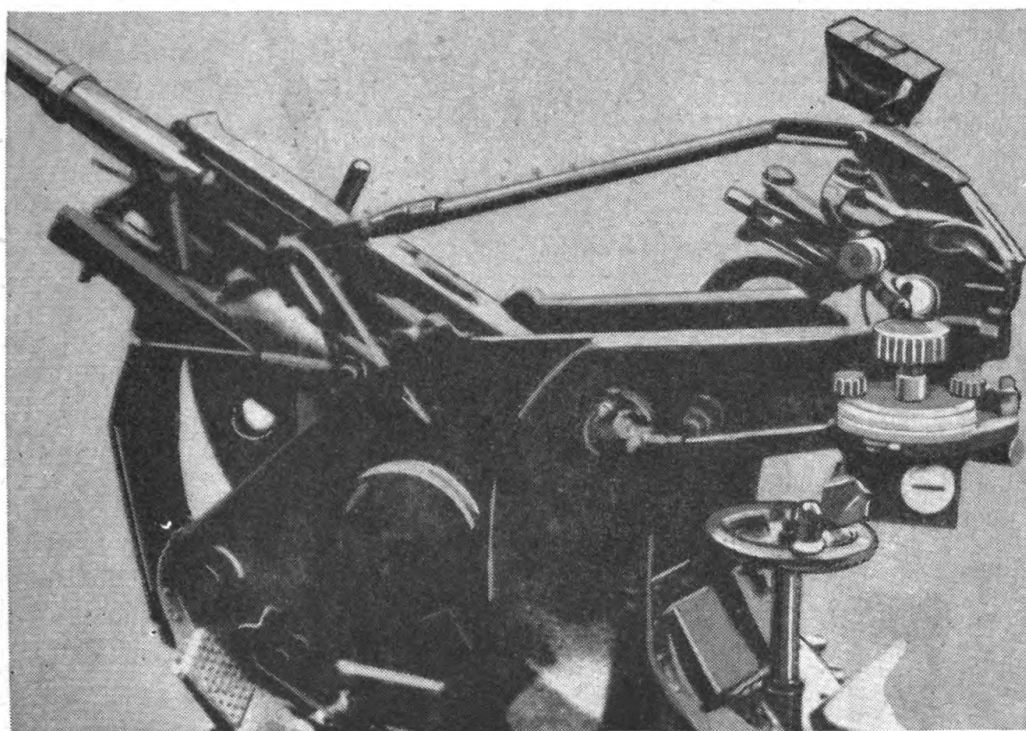


FIGURE 44.—Flakvisier 35 in position—left side view.

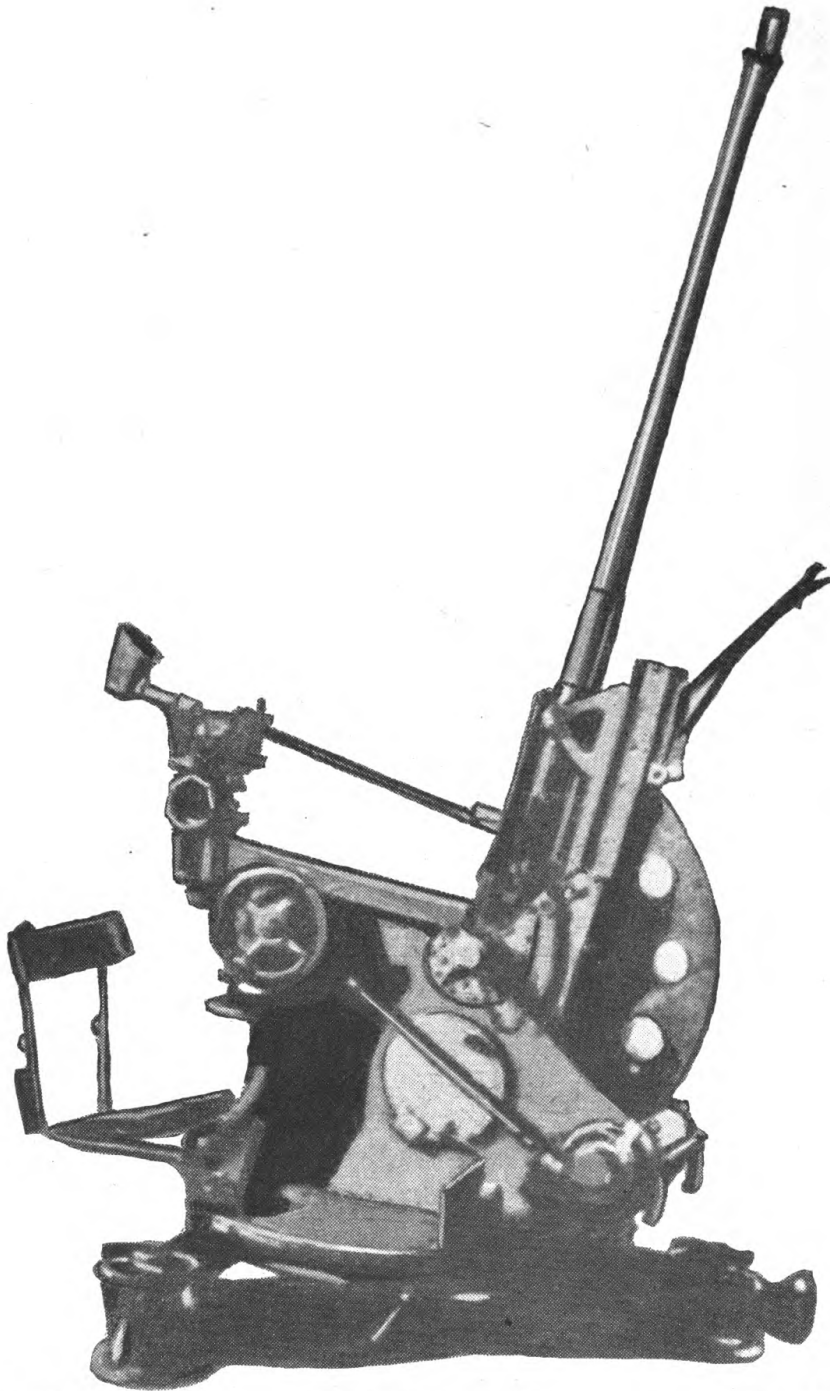


FIGURE 45.—Flakvisier 35 on 2-cm Flak 30 (20-mm antiaircraft gun, single-barreled mount).

## SECTION VIII

## LINEALVISIER 21 (LINEAR SIGHT 21)

	Paragraph
Characteristics and data.....	48
Description and method of operation.....	49
Operation.....	50

**48. Characteristics and data.**—*a. Characteristics.*—Linealvisier 21 (linear sight 21) is an alternate sight to Flakvisiers 35, 38, and 40 on the 2-cm Flak 30, the 2-cm Flak 38, and 2-cm Flakvierling 38, respectively (see par. 5 and sec. VII). It can be used against air targets and moving or fixed land and sea targets. Range, course of target, speed of target, angle of dive or climb, and superelevation are taken into account.

*b. Data.*

Target speed..... 24 to 335 miles per hour.  
 Range (antiaircraft targets)..... 109 to 1,750 yards.  
 Range (land or sea targets)..... 109 to 1,750 yards.  
 Angle of dive or climb..... No limits.

**49. Description and method of operation** (figs. 46 to 49, incl.).—*a.*—Linealvisier 21 consists of the following three main parts:

(1) The holder, which is fixed to the carriage and fastened to the elevation arm.

(2) The bracket (1), which is mounted on the holder by two pins and a clamping screw. The pins are parallel to the axis of the bore, and the bracket is fastened to them by two suspension claws (2) and the clamping screw (3). There are two holes in the bracket for the sight.

(3) The sight, which consists mainly of the following:

(a) Slit guide (4).

(b) Backsight bracket (5) and glass backsight (6).

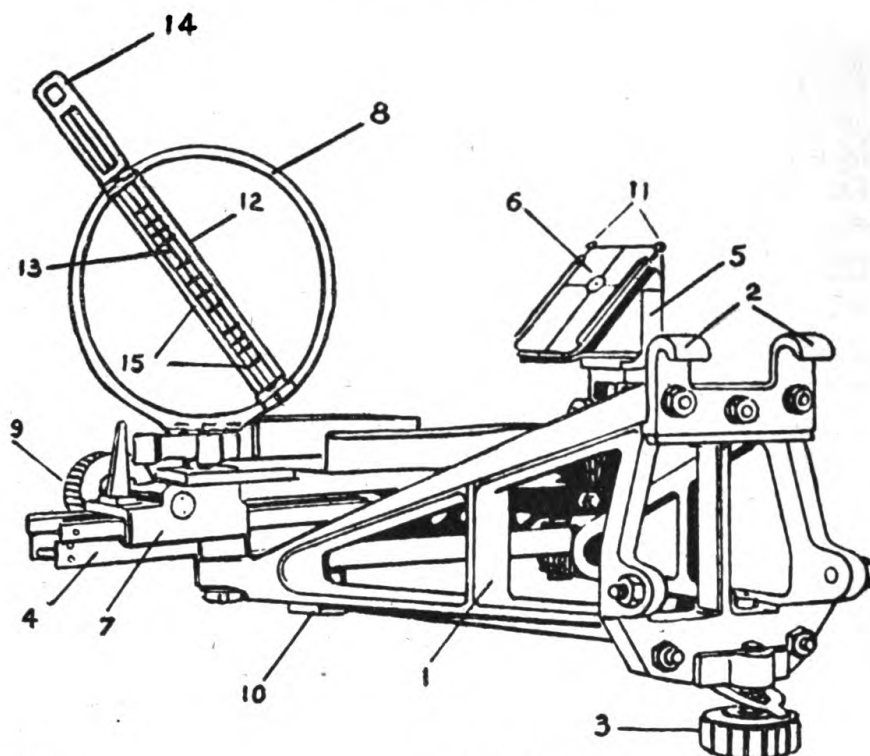
(c) Slide (7) and ring foresight (8).

(d) Superelevation gear.

*b.* At one end of the sight is a joint for the backsight bracket which, together with the backsight, can be moved up and down by means of a link.

*c.* Range is put in by turning range knob (9) until the index on the slide is opposite the range ordered on the slit guide scale. The scale is marked from 100 to 1,600 meters in 100-meter steps.

*d.* The backsight consists of two parallel plates of glass set obliquely at an angle of 45° in the bracket. This enables the gun commander to check that the layer is laying correctly, and that he sets in course and corrections correctly. By looking down at the



- |                       |                                  |
|-----------------------|----------------------------------|
| 1. Bracket.           | 9. Range knob.                   |
| 2. Suspension claws.  | 10. Driving disk.                |
| 3. Clamping screw.    | 11. Backsight retaining springs. |
| 4. Slit guide.        | 12. Rule.                        |
| 5. Backsight bracket. | 13. Aiming line.                 |
| 6. Backsight.         | 14. Setting handle.              |
| 7. Slide.             | 15. Speed scale.                 |
| 8. Ring foresight.    |                                  |

FIGURE 46.—Sketch of Linealvisier 21.

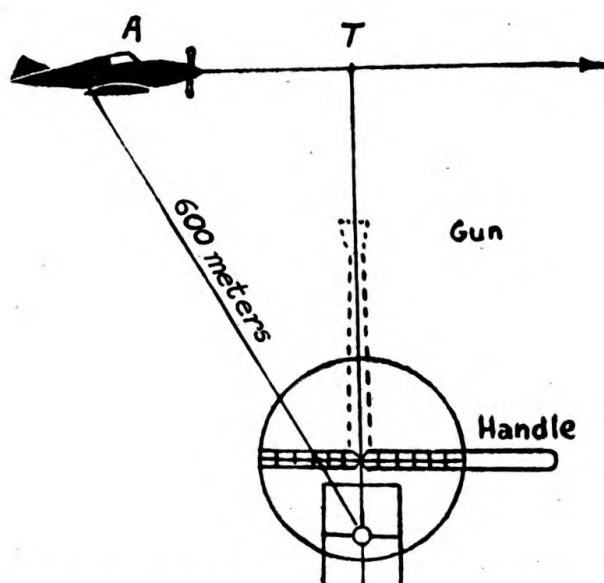


FIGURE 47.—Sighting the target with Linealvisier 21.



backsight, the gun commander can see the position of the target in relation to the foresight.

*e.* The field of view of the backsight is a cross with an aperture in the middle. The backsight, which is movable, is held by two springs (11).

*f.* The rule (12), which is movably mounted on a folding ring (8), acts as a foresight. The ring is moved on its axis to bring it parallel with the course of the target. The rule is a movable bar, through the middle of which is the aiming line (13). Both course of target and corrections are set by handle (14). The center mark represents an aircraft speed of about 11 meters per second (24 miles per hour). The scale on the rule provides for the following target speeds:

<i>Speed</i>	<i>Graduation color</i>
35 meters per second (78 mph)-----	White.
70 meters per second (156 mph)-----	Red.
85 meters per second (190 mph)-----	Yellow.
100 meters per second (225 mph)-----	White.
120 meters per second (268 mph)-----	Red.
150 meters per second (335 mph)-----	Inner edge of ring.

*g.* The driving disk (10) displaces the ring to make allowance for superelevation for the angle of sight concerned. When set at *Erde* (land), it sets in superelevation for angles of sight from  $-10^{\circ}$  to  $+20^{\circ}$ , and when at *Luft* (air) for angles of sight from  $+20^{\circ}$  to  $+90^{\circ}$ .

**50. Operation.**—*a. Operation.*—(1) Lay on the target through the aperture in the backsight according to the appropriate speed mark on the rule, thus applying the correct deflection (fig. 47).

(2) With a crossing target, use the half of the rule nearest the target.

(3) The rule is set perpendicular for an approacher or receder. With an approacher the lower half is used, and with a receder the upper half.

(4) Set in range.

(5) Set course by moving the ring, and corrections by moving the rule (figs. 48 and 49.)

*b. Corrections.*—(1) *Crossing target.*—If fire is in front of or behind the target, a different target speed must be used. High or low shooting is corrected by adjusting the rule with the handle (fig. 48).

(2) *Approacher or receder.*—Lateral errors are corrected by moving the rule (fig. 49); vertical errors, by using a different target speed.

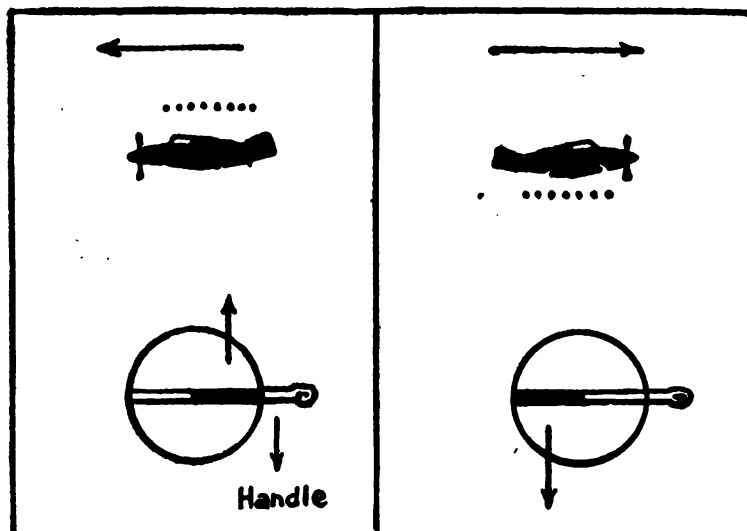


FIGURE 48.—Crossing the target.

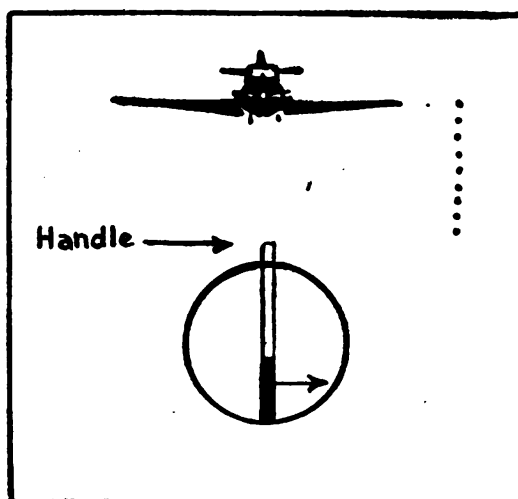


FIGURE 49.—Approaching the target.

## SECTION IX

## 1-METER (39.37-INCH)-BASE RANGE FINDER

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Preliminary adjustments and other characteristics.....	52

**51. General.**—*a.* The 1-meter (39.37-inch)-base range finder (fig. 50) is employed by light antiaircraft detachments manning the 2-cm Flak 30, the 2-cm Flak 38, the 2-cm Flakvierling 38, and the 3.7-cm Flak 36 (fig. 50). Magnification is sixfold, and the range is from 800 to 26,200 feet. When in use this instrument is usually strapped to the rang-taker's shoulders, but there is also provision for a small tripod.

b. The instrument is manufactured by Carl Zeiss of Jena. It is of the standard stereoscopic pattern, estimation of distance being by means of two reticles, one in each eyepiece, which when "fused" stereoscopically appear superimposed upon the image in depth. The instru-



FIGURE 50.—1-meter-base range finder in use with 3.7-cm Flak 36 (37-mm antiaircraft gun, single-barreled mount).

ment is difficult to handle, and considerable practice is necessary before an operator can obtain satisfactory results. It has the great advantage that once the preliminary adjustments are made, ranges

can be estimated continuously and instantaneously without further manipulation.

**52. Preliminary adjustments and other characteristics.—**

The preliminary adjustments are as follows:

- a. Focusing of each eyepiece independently.
- b. Interocular distance.
- c. Height of image.
- d. Infinity.
- e. In addition, two astigmatizers are provided, the purpose of which is not clear. Their astigmatic effect is very slight and amounts to little more than loss of definition.
- f. The range finder incorporates a mechanism for changing, by the turn of a lever, from the pair of reticles etched with the stereoscopic scale to an alternate pair, one of which is plain and the other etched with a grid of eight divisions each way, occupying between  $2^\circ$  and  $2^\circ 30'$  in the center of the field of view. These divisions are of the following value: in elevation, one division =  $\frac{5}{16}^\circ$  (5.55 mils); in azimuth, one division =  $\frac{9}{32}^\circ$  (5 mils). (This arrangement permits correction of fire from observation.)

## SECTION X

### AMMUNITION

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Armor-piercing .....	55

**53. General.**—Ammunition for the 2-cm Flakvierling 38 is of two types: high-explosive and armor-piercing. Only ammunition which has been manufactured for use in the guns mounted on the 2-cm Flakvierling 38 should be used.

**54. High-explosive.—a. Data.**

Weight of complete round.....	10.6 ounces.
Weight of projectile.....	4.1 ounces.
Length of cartridge case.....	5.44 inches.
Length of complete round.....	8.99 inches.
Type of cartridge.....	Brass.
Type of fuze.....	Supersensitive self-destroying.
Range of tracer (time of flight, 6,500 feet (2,000 meters). 5.5 seconds). <sup>16</sup>	

<sup>16</sup> An increase of tracer composition sometimes included in the HE shell gives a time of flight of 6 seconds to an effective ceiling of 7,215 feet.

**b. Markings.****High-explosive tracer:**

Fuze .....	Aluminum.
Shell body .....	Yellow and red strip above driving band (which is of sintered iron).

**High-explosive:**

Fuze .....	Aluminum.
Shell body .....	Yellow.

**High-explosive tracer:<sup>17</sup>**

Shell body .....	Yellow with 6-mm black strip 2-mm above driving band.
------------------	---

**55. Armor-piercing.—a. Data.**

Weight of complete round .....	11.6 ounces.
Weight of projectile .....	5.2 ounces.
Length of cartridge case .....	5.44 inches.
Length of complete round .....	8.05 inches.
Type of cartridge .....	Brass.

**b. Markings.****Armor-piercing tracer:**

Shell body .....	Black and yellow band above driving band.
------------------	---

**Armor-piercing incendiary (phosphorous):**

Shell body .....	Black with ¼-inch yellow band above driving band, the letters "Ph" stenciled in white above yellow band.
------------------	--

**Armor-piercing incendiary (thermite):**

Shell body .....	Black and red nose with ⅛-inch red band immediately above driving band.
------------------	---

<sup>17</sup> The HE filling appears to consist of penthrate wax with a large quantity of magnesium flakes intermixed. The whole filling is a pressed pellet with a short-delay detonator in the bottom end. It is considered that this may give a flash with greater incendiary effects.

## SECTION XI

SPARE PARTS AND ACCESSORIES<sup>18</sup>

	Paragraph
Spare parts and accessories.....	56
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**56. Spare parts and accessories.**—*a.* The following spare parts and accessories are stored in the trail box:

- 1 open-end wrench, 11 by 14 mm.
- 1 open-end wrench, 14 by 17 mm.
- 1 open-end wrench, 22 by 27 mm.
- 1 hexagonal box wrench, open-end, 11 by 14 mm.
- 1 hexagonal box wrench, open-end, 17 by 22 mm.
- 1 extension lever for box wrench for 12- to 14-mm jaw.
- 1 extension lever for box wrench for 22- to 27-mm jaw.
- 1 screw driver for screws 0.6- to 0.8-mm width of slot.
- 1 pair of pliers for (seeger) washers for shafts of 12 to 25 mm.
- 1 pair of pliers for (seeger) washers for bores of 26 to 70 mm.
- 1 pair of pliers for (seeger) rings for bores of 26 to 70 mm.
- 2 punches.
- 1 hammer.
- 1 mandril.
- 1 cartridge case remover.
- 1 taper pin.
- 1 set of cables (4).
- 2 pulleys.
- 1 bushing remover.
- 1 can, 56-mm diameter and 70-mm height, for grease.
- 2 meters (6 feet 6 inches) of 1-mm (0.04-inch) diameter steel wire, annealed.

In addition, there are belts, a gun cover, etc.

*b.* Where the purpose of the accessories is not clear from their specification, or when ordinary tools are not available, the following point should be noted: the punch, in conjunction with the hammer and mandril, is used for the purpose of freeing the breech when it sticks. It is required only for 2-cm Flak 38 guns mounted on the 2-cm four-barreled antiaircraft mount 38.

**57. Use of spare parts and accessories.**—*a. Punch and hammer.*—(1) By pulling the knob, operate chain hoist until resistance

<sup>18</sup> Castle nuts and cotter pins are used most liberally in the assembly, and no nut is used without a spring washer to lock it.



is felt. Insert punch so that the strip on the rounded portion comes between the breech head and the guide piece, the smooth side resting on the guide piece.

(2) By pulling the handle of the hoist and at the same time striking the mandril (the chisel edge of this mandril should be applied to the middle strip of the punch or striker piece), the sticking breech will be freed.

(3) Strike only in the direction of the breechblock while the handle of the hoist is being pulled backward. Do not strike in the direction of the muzzle.

*b. Cartridge case remover.*—This is used for emptying the deflector box.

*c. Gun cover.*—This is used for covering the gun while it is on the trailer, and when it is not in use.

*d. Belts.*—These are used for strapping on the gun commander and the layer when the gun is being fired from moving vehicles or from railway cars.

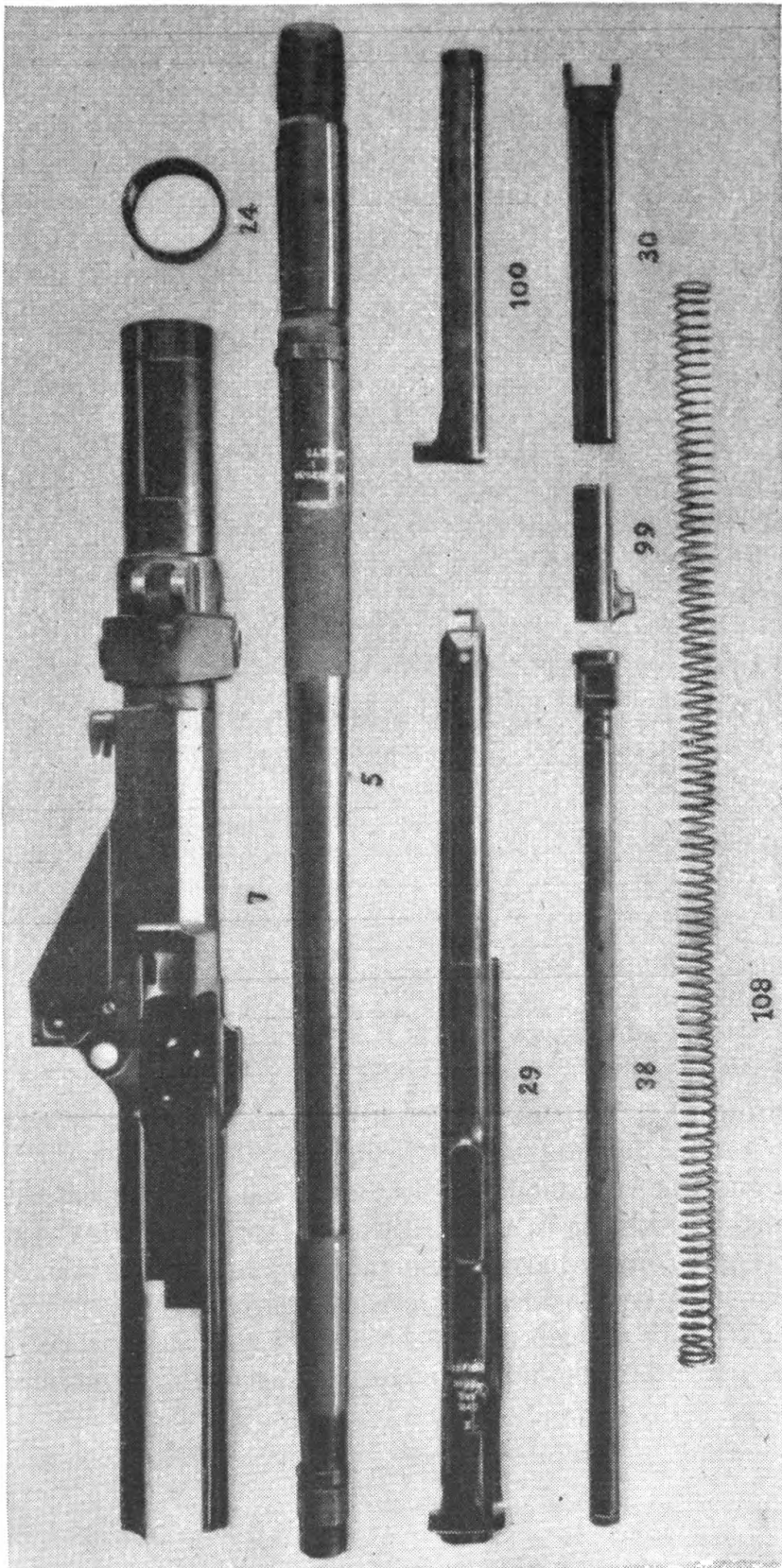
## SECTION XII

### 2-CM FLAK 30 (20-MM ANTIAIRCRAFT GUN, SINGLE-BARRELED MOUNT)

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To fire.....	62
To disassemble and assemble.....	63
Care and preservation.....	64
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**58. General.**—*a. Purpose.*—The information in this section can be used so far as it is applicable to the 2-cm Flakvierling 38. The 2-cm Flak gun is a later model of the 2-cm Flak 30 gun (see par. 1g).

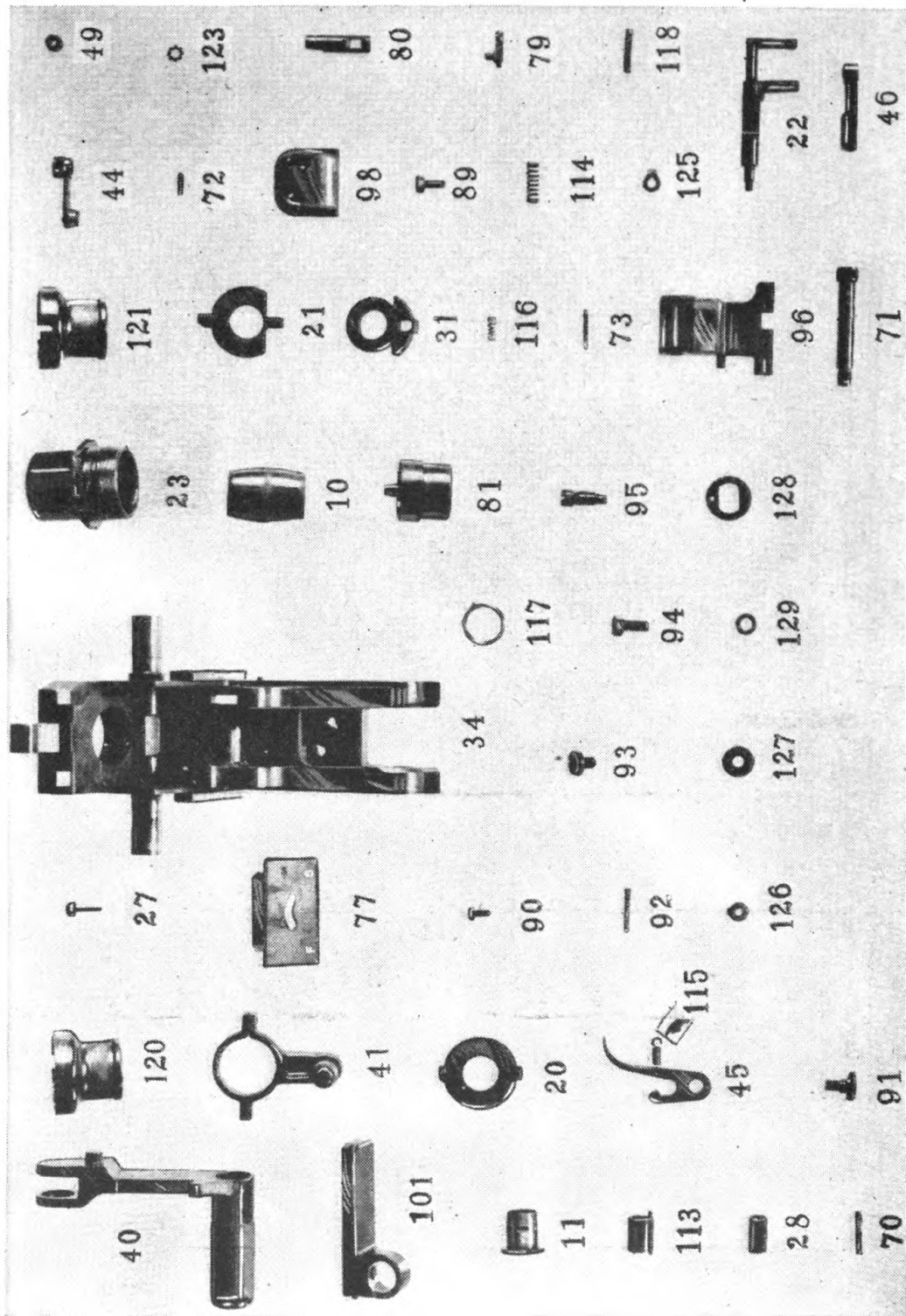
*b. Scope.*—In addition to a description of the 2-cm Flak 30 (20-mm antiaircraft gun, single-barreled mount), this section contains technical information on the identity, use, and care of the gun. Repair work, which is not described and which is beyond the scope of the using arms personnel, should be performed by qualified maintenance personnel.



①

- 5. Barrel.
- 7. Body (receiver).
- 24. Cap, screwed, receiver.
- 29. Cover, receiver.
- 30. Casing, recoil springs.
- 98. Guide, return spring, breechblock.
- 99. Sleeve, recoil springs.
- 100. Sleeve, spring, return, breechblock.
- 108. Spring, return, breechblock.

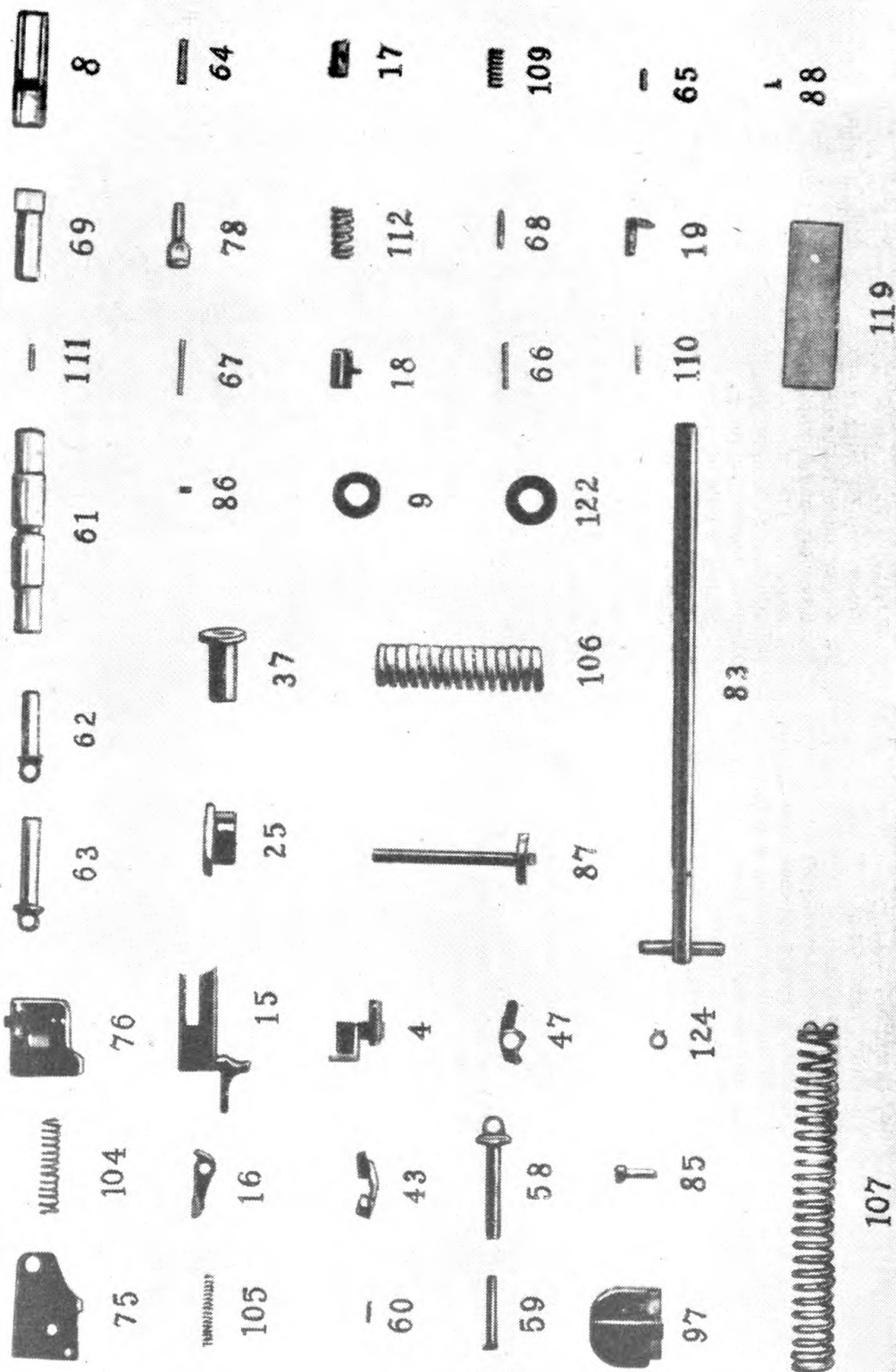
FIGURE 51.—Parts for 2-cm Flak 30.



③

10. Buffer, rubber, breechblock.
11. Bushing pivot, charging handle.
20. Catch, left, sear.
21. Catch, right, sear.
22. Catch, safety.
23. Cap, buffer, breechblock.
27. Cotters, spring, catches, sear (2).
28. Collar, inner, charging handle.
31. Disk, catch, right, sear.
34. Extension, receiver.
40. Handle, charging.
41. Handles, trigger (2).
44. Lever, pin, axis, sear.
45. Lever, auxiliary, sear.
46. Lever, safety.
49. Nut, catch, safety.
70. Pin, fixing, handle, charging.
71. Pin, axis, sear.
72. Pin, fixing, lever, pin, axis, sear.
73. Pin, fixing, disk, right, sear.
77. Plate, indicator, fire control.
79. Plunger, levers, safety.
80. Plunger, safety catch.
81. Plunger, buffer, breechblock.
89. Screws, shoulder cam, unlocking (2).
90. Screws, handles, triggers (4).
91. Screw, axis, lever, auxiliary, sear.
92. Screw, fixing, spring, lever, auxiliary, sear.
93. Screw, spindle, triggers (2).
94. Screws, plate, indicator, fire control (2).
95. Screw cap, buffer, breechblock.
96. Sear.
98. Shoulder cam, unlocking.
101. Slide, handle, charging.
113. Spring, handle, charging.
114. Spring, sear.
115. Spring, lever, auxiliary, sear.
116. Spring, disk, catch, right, sear.
117. Springs, catch, sear (2).
118. Spring, plunger, lever, safety.
120. Trigger, left.
121. Trigger, right.
123. Washer, nut, catch, safety.
125. Washers, screw, shoulder, unlocking (2).
126. Washers, screw, handles, trigger (4).
127. Washers, locking screws, spindle triggers (2).
128. Washers, trigger (2).
129. Washers, spring, screw plate, indicator, fire control (2).

FIGURE 51.—Parts for 2-cm Flak 30—Continued.

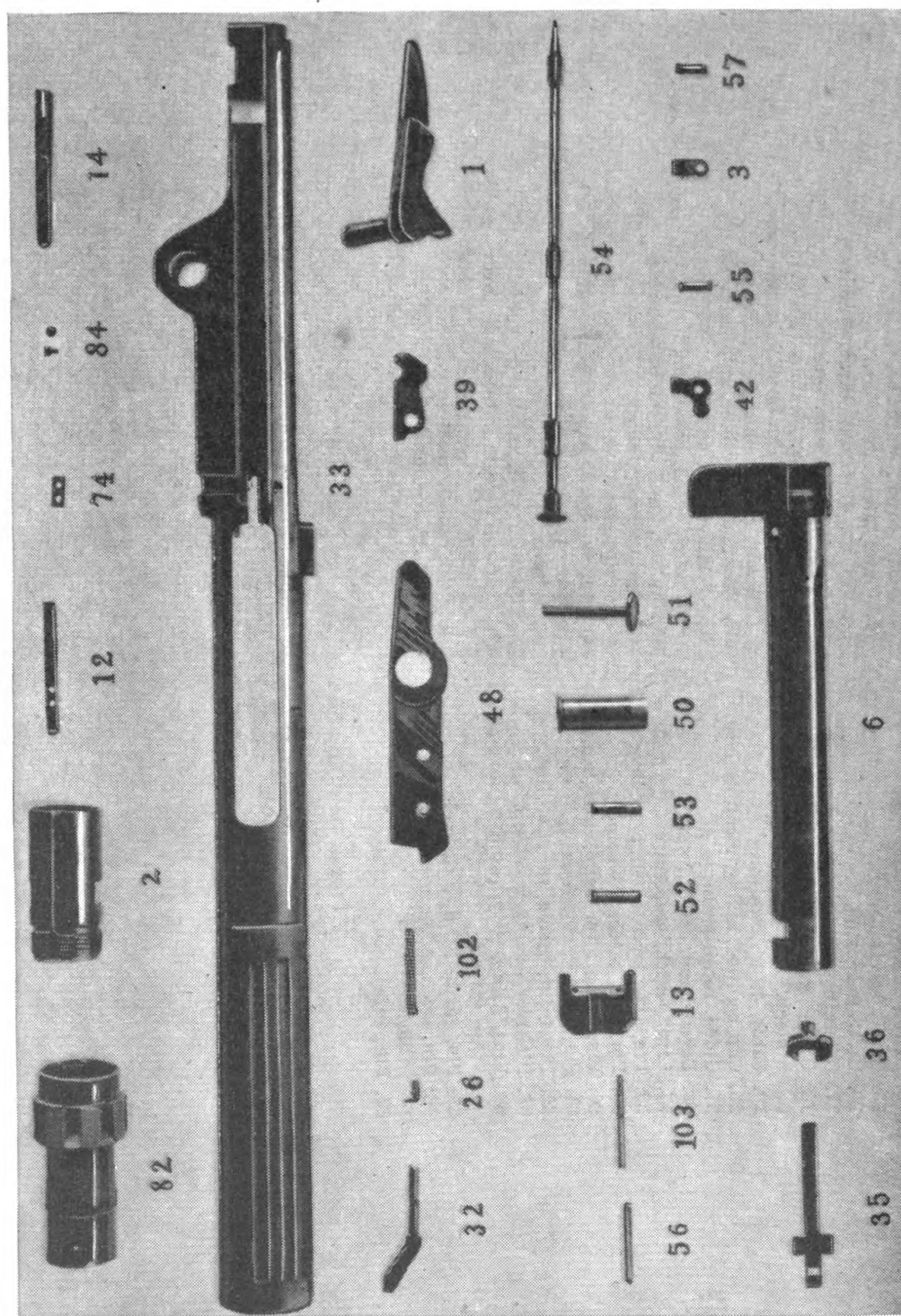


⑧



4. Auxiliary catch, magazine.
8. Body (receiver) catch, handle, charging.
9. Buffer, rubber, barrel.
15. Catch, breechblock.
16. Catch, magazine.
17. Catch, handle, charging.
18. Catch, guide, spring, return, breechblock.
19. Catch, cover, receiver.
25. Cap, screwed, casing, recoil springs.
37. Guide, recoil springs.
43. Lever, hand, catch, magazine.
47. Lever, catch, breechblock.
58. Pin, axis, lever, catch, breechblock.
59. Pin, axis, catch, magazine.
60. Pin, fixing, lever, hand, catch, magazine.
61. Pin, bracket, mount, rear.
62. Pin, front, casing, recoil springs.
63. Pin, rear, casing, recoil springs.
64. Pins, fixing, body, catch, handle, charging (2).
65. Pin, catch, handle, charging.
66. Pin, catch, guide, spring, return, breechblock.
67. Pin, catch, cover, receiver.
68. Pin, plunger, steadying, cover, body.
69. Pin, axis, cover, (receiver).
75. Plate, catch, magazine.
76. Plate, catch, breechblock.
78. Plunger, steadying, cover, (receiver).
83. Rod, tension, recoil springs.
85. Screws, shoulder, locking cam (2).
86. Screw, fixing, pin, bracket, mount, rear.
87. Screw, rod, tension, recoil springs.
88. Screw, fixing, rubber, stop, receiver.
97. Shoulder cam, locking.
104. Spring, catch, breechblock.
105. Spring, auxiliary, catch, magazine.
106. Spring, recoil, short.
107. Spring, recoil, long.
109. Spring, catch, handle, charging.
110. Spring, catch, guide spring, return, breechblock.
111. Spring, catch, cover, receiver.
112. Spring, plunger, steadying, cover, receiver.
119. Stop, rubber, receiver.
122. Washer, recoil springs (2).
124. Washers, screw, shoulder, locking (2).

FIGURE 51.—Parts for 2-cm Flak 30—Continued.



④

- |                                    |  |
|------------------------------------|--|
| 1. Accelerator.                    | 50. Pin, axis, locking piece.                        |
| 2. Adapter, brake, muzzle.         | 51. Pin, split pin, axis, locking piece.             |
| 3. Arm, safety, barrel extension.  | 52. Pin, axis, hammer.                               |
| 6. Breechblock.                    | 53. Pin, stop, hammer.                               |
| 12. Catch, adapter, brake, muzzle. | 54. Pin, firing.                                     |
| 13. Catch, locking piece.          | 55. Pin, axis, lever, firing pin.                    |
| 14. Catch, barrel.                 | 56. Pin, catch, locking piece.                       |
| 26. Cotter ejector.                | 57. Pin, arm, safety, barrel, extension.             |
| 32. Ejector.                       | 74. Plate, catch, adapter, brake, muzzle.            |
| 33. Extension, barrel.             | 82. Reducer, recoil (muzzle brake).                  |
| 35. Extractor.                     | 84. Screws, place catch, adapter, brake, muzzle (2). |
| 36. Face, breechblock.             | 102. Spring, ejector.                                |
| 39. Hammer.                        | 103. Spring, catch, locking piece.                   |
| 42. Lever, firing pin.             |  |
| 48. Locking piece.                 |  |

FIGURE 51.—Parts for 2-cm Flak 30—Continued.

**59. Characteristics.****Muzzle velocity:**

High-explosive-----	2,950 feet per second.
Armor-piercing-----	2,625 feet per second.
Maximum horizontal range-----	5,230 yards.
Maximum vertical range-----	4,030 yards.
Effective ceiling-----	2,400 yards.
Time of flight to effective ceiling----	6 seconds.
Theoretical rate of fire-----	280 rounds per minute.
Practical rate of fire-----	120 rounds per minute.
Weight of barrel-----	40 pounds.
Length of barrell (65 cal)-----	51.2 inches.
Length of rifling (57.97 cal)-----	45.6 inches.
Twist of rifling-----	5° (constant).
Number of grooves-----	8.
Depth of grooves-----	0.014 inch.
Width of grooves-----	0.21 inch.
Distance between lands-----	0.1 inch.
Recoil of barrel-----	1.38 to 1.77 inches.

**60. Description.**—*a. General.*—The components of the gun may be grouped as follows:

*(1) Moving parts.*

*(a)* Barrel with recoil reducer (muzzle brake).

*(b)* Barrel extension with locking piece, hammer, and locking piece catch.

*(c)* Breechblock with extractor, face breech, firing pin, and lever.

*(2) Stationary parts.*

*(a)* Receiver with accelerator, barrel return spring assembly, magazine catch and spring, breech catch and spring, and locking cam.

*(b)* Receiver cover with breechblock return spring, charging handle, and slide.

*(c)* Receiver extension with buffer, trigger mechanism, and unlocking cam.

*b. Moving parts.*—(1) The barrel slides in the receiver with the barrel extension. It is assembled to the extension by means of an interrupted thread and is secured radially by a catch housed in the barrel extension. A combined muzzle brake and flash hider is screwed on the muzzle and retained by a catch.

(2) The barrel extension is mainly tubular in form and is slotted on the right and left sides for ejection and feed, respectively. At the rear end it is open at the top to permit the passage of the accelerator lug on the breechblock, and at the bottom to accommodate

the pivoting locking piece and its catch. A lug is provided on the top to actuate the accelerator, and a recess beneath receives the barrel return spring sleeve stud. A spring ejector is housed on the left side.

(3) The breechblock is cylindrical, with a lug on top for accelerator contact and charging action. It contains the breech face, firing pin and lever, and extractor. The front end is recessed for the cartridge head, and the rear end has a projection underneath which forms a locking shoulder at the rear and a notch for the sear at the front.

*c. Stationary parts.*—(1) The receiver is formed to receive the barrel extension, and has a pair of trunnion holes toward the front. A magazine housing is provided on the left, and the right side is slotted for ejection. The locking cam and hammer lug shoulder are situated in a recess below the breechblock slide.

(2) The barrel return spring, buffer spring, buffer, rod, and sleeve are contained in a casing which is pivoted to the body at its rear end, and fastened by a transverse pin at the front. The accelerator is pivoted on top and the rear end is closed by the hinged body extension. The magazine catch, breech catch, and breech catch lever are contained at the rear of the magazine opening.

(3) The receiver cover is hinged to the receiver at the front end and secured by a catch at the rear. It contains the return spring, sleeve, and guide. The charging handle slides in a groove on the right side and is provided with a retaining catch.

(4) The receiver extension is hinged near the rear end of the receiver and is secured by a rotating transverse pin. Traversing handles are provided on each side, each handle forming a pivot for a rotary trigger. It carries the sear and safety mechanism, which embodies automatic and single-shot firing. The safety catch lever which operates the safety mechanism is situated at the rear. The unlocking cam is located near the front, and the breechblock buffer is housed at the rear.

(5) The magazine is of the box type and holds 20 rounds in two staggered rows.

**61. Functioning.**—*a. Automatic fire.*—(1) *Forward travel of breechblock.*—On rotating the left trigger, the trigger stud withdraws the sear from its notch on the breechblock. The breechblock return spring then reacts and drives the breechblock forward, the latter forcing a round out of the magazine into the chamber and also returning the accelerator to its forward position.

(2) *Forward movement of barrel and locking of breech.*—The sear notch on the breechblock then releases the locking piece catch, and the extractor engages the rim of the cartridge in the chamber. The barrel return spring then reacts, and the breechblock, barrel exten-

sion, and barrel travel forward together. During this period the locking piece rides up the locking cam and engages the locking face on the breechblock, thus locking the breech.

(3) *Completion of forward movement and firing.*—During the closing stages of the forward movement, the firing pin lever is released and the hammer is rotated, by contact with a stop in the receiver, thus driving the firing pin forward and striking the cap. At this moment the forward movement is terminated by the barrel extension abutting on its stop in the body.

(4) *Rearward travel of barrel, barrel extension, and breechblock.*—During the process of recoil, the barrel, barrel extension, and breechblock are driven to the rear, compressing the barrel and breechblock return spring. After a travel of approximately 1 inch, the rear end of the locking piece rides up a cam on the receiver extension, thereby rotating the locking piece and unlocking the breech.

(5) *Termination of rearward movement of barrel and barrel extension, and continued rearward travel of breechblock.*—The accelerator, actuated by the barrel extension, then drives the breechblock to the rear; the firing pin is withdrawn by its lever; the hammer has dropped into its recess in the locking piece; and the locking piece is retained in the unlocked position by the locking piece catch. Rearward travel of the barrel and barrel extension is then terminated by barrel buffer action, and they are retained by engagement of the locking piece with its catch.

(6) *Extraction, ejection, and termination of rearward travel of breechblock.*—The breechblock continues to travel to the rear, extracting and ejecting the fired case. Rearward travel of the breechblock is then terminated by full compression of its return spring and abutment on the buffer in the body extension. This completes the cycle of action, and if the trigger is still held, the gun will continue to fire until the magazine is empty.

(7) *Empty magazine.*—When the magazine is empty, a stud on the magazine platform depresses the magazine catch and releases the magazine. The breech catch then travels across the path of the breechblock and retains the latter in the rear position.

(8) *Cessation of fire before magazine is empty.*—On releasing the trigger, the sear rises and retains the breechblock in the rear position; firing then ceases with the breech open.

*b. Single-shot fire.*—On rotating the right trigger, the trigger stud rotates the sear, thereby withdrawing the sear from the sear notch of the breechblock and releasing the breechblock. On further rotation of the trigger, cam action withdraws the stud from the sear, which rises again under the influence of its spring and is thus ready



to retain the breechblock on its return to the rear position. On releasing the trigger, the latter returns under spring action, and the trigger stud reengages the sear, and is thus ready for sear release when the trigger is again rotated.

**62. To fire.—a. General.**—(1) Always set the gun at “safe” when not actually firing. The safety catch lever is situated at the rear of the receiver extension.

(2) When the magazine is empty, the magazine platform releases the magazine catch, and the breechblock is retained in the rear position by the breech catch.

(3) If, when cocking, the barrel extension is not pulled far enough back for the unlocking ramp to throw the locking piece into engagement with its catch, reaction of the barrel return spring will cause the locking piece to jam the breechblock. This jam can be cleared by having two men grasp the barrel, pull it to the rear slightly, and then let it go forward.

(4) If it is desired to close the breech when the magazine is not assembled, it will be necessary to pull the breech catch out of engagement by hand before releasing the sear. It is easier to release the breech catch by having another man pull the breechblock slightly to the rear by means of the charging handle and then return the charging handle to the forward position.

(5) Never push the breechblock forward until the chamber is clear.

**b. To prepare for firing.**—(1) See that the gun is normally lubricated with oil, lubricating, preservative, light, and that the bore of the barrel is dry.

(2) Set the safety catch lever at “S” (*Sicher*, safe).

(3) Pull the charging handle smartly to the rear until the breechblock is retained by the breech catch, and return the charging handle to the forward position.

(4) Insert a loaded magazine into its recess in the left side of the body, where it will be retained by the magazine catch. The breech catch is now released and the breechblock is retained by the sear.

(5) Set the safety catch lever at “F” (*Feuer*, fire).

(6) Single shots can be fired by rotating the right trigger. For automatic fire, rotate the left trigger.

(7) During continuous fire, the barrel must be changed after 6 magazines (120 rounds). If possible, it should be changed after 80 to 100 rounds.

**c. To unload.**—(1) Set the safety catch lever at “S.”

(2) Push the magazine catch lever to the right and remove the magazine.

(3) Examine the chamber to see that the gun is clear.

**63. To disassemble and assemble.**—*a. To strip gun.*—See that the breech is closed.

*b. To remove barrel.*—Raise the barrel catch clear of the retaining groove and release it as soon as the barrel is turned. Turn the barrel to the left until the stop face contacts with the barrel catch. Withdraw the barrel from the receiver.

*c. To remove breechblock.*—(1) Remove the front securing pin, which is part of the barrel return spring unit on the underside of the gun, and lever with a screw driver. The unit will now disengage from the barrel extension.

(2) Depress the receiver cover catch stop, push forward the receiver cover catch, and raise the receiver cover until it rests on the receiver.

(3) Grasp the accelerator and pull the breechblock to the rear until the locking piece is depressed and retained by its catch.

(4) Turn the receiver extension locking lever down to the unlocked position, swing the receiver extension down 90°, and remove the breechblock from the receiver.

*d. To remove firing pin from breechblock.*—Remove the firing pin lever axis pin and firing pin lever, and withdraw the firing pin.

*e. To remove breech face from breechblock.*—Place a screw driver under the claw of the extractor and pry the extractor out of the breechblock. Rotate the breech face and lift it out.

*f. To remove barrel extension.*—Lift out the accelerator. Hold the breech catch fully out and withdraw the barrel extension from the receiver.

*g. To remove breechblock return spring, guide, and sleeve.*—Support the breechblock return spring guide, depress the breechblock return spring guide catch, and ease out the guide, spring, and sleeve.

*h. Complete disassembly.*—Further stripping is unnecessary for cleaning, and in any case should be undertaken only by qualified maintenance personnel.

*i. To assemble.*—Follow the reverse order of disassembly, noting the following:

(1) When replacing the barrel extension, it is necessary to hold the breech catch out, to see that the safety arm is flush with the side of the extension, and to see that the locking piece is correctly positioned.

(2) When replacing the barrel return spring unit, it is necessary to slam it into engagement, owing to the initial compression of the springs.

(3) To avoid risk of personal injury, special care should be taken to prevent the body cover from falling from the raised position.

**64. Care and preservation.**—*a. Cleaning instructions.*—(1) Before and after each session of firing, the gun should be disassembled and thoroughly cleaned and oiled. In cleaning the bore, use cleaner, rifle bore, applied with a sponge. If this is not available, use a strong solution of issue soap and hot water. Swabbing of the bore should be repeated until a clean flannel patch picks up no foreign matter. When the bore is clean and dry, oil it with oil, lubricating, preservative, light.

(2) Clean all moving parts with solvent, dry-cleaning, and wipe them dry with a clean firm cloth. When cleaning oil cups, open holes, and sliding surfaces, wipe them with a firm cloth. No lint should be allowed to remain in any openings or sliding parts.

(3) All cleaned parts should be examined for wear, scoring, burs, and cracks, and then should be oiled and assembled.

*b. Lubrication instructions.*—(1) Particular attention should be given to the lubrication of sliding surfaces of the operating mechanism of the gun and other bearing surfaces that do not contain oilholes, plugs, or lubricating fittings.

(2) Lubricate the bore, the breechblock, the barrel extension, and other working parts with oil, lubricating, preservative, light. If this is not available, use oil, lubricating, for aircraft instruments and machine guns. When, however, the latter lubricant is used, inspection and lubrication must be made at intervals of not more than 24 hours, as this oil has almost no preservative qualities. Apply the lubricant with an oiled cloth or oiler after firing, or daily while on alert.

(3) After firing, clean the bore as specified in *a*(1), above, and lubricate it with oil, lubricating, preservative, light.

(4) Always lubricate very lightly. Excess oil will impair operation at low temperatures.

**65. Ammunition.**—*a. Caution.*—Only ammunition which has been manufactured for the 2-cm Flak 30 should be used in this gun. Ammunition which is not definitely known to be applicable should be carefully tested before use.

*b. High-explosive tracer (self-destroying).*

Weight of complete round.....	10.7 ounces.
Length of complete round.....	7.95 inches.
Weight of propellant.....	1.41 ounces.
Fuze, PD (aluminum).....	AZ 5045.
Weight of projectile.....	4.1 ounces.
Weight of filling (penthrite wax).....	94 grains.

- |               |  |
|---------------|--|
| Trace-----    | Pale green, burning statically<br>for 6.4 seconds.                               |
| Markings----- | Annulus black; projectile yellow,<br>and may have white band above driving band. |
- c. High-explosive tracer (self-destroying), streamline.*
- |   |  |
|---|--|
| Weight of complete round-----             | 10.6 ounces.                                       |
| Length of complete round-----             | 7.92 inches.                                       |
| Weight of propellant-----                 | 1.29 ounces.                                       |
| Fuze, PD (aluminum)-----                  | AZ 5045.   |
| Weight of projectile-----                 | 4.2 ounces.  |
| Weight of filling (penthrite<br>wax)----- | 94 grains.   |
| Trace-----                                | Pale green, burning statically<br>for 6.4 seconds. |
| Markings-----                             | Annulus black; projectile yellow.                  |
- d. High-explosive incendiary tracer (self-destroying), streamline.*
- |  |  |
|--|--|
| Weight of complete round-----                                | 10.24 ounces.  |
| Length of complete round-----                                | 7.95 inches.   |
| Weight of propellant-----                                    | 1.29 ounces.   |
| Fuze, PD (aluminum)-----                                     | AZ 5045.   |
| Weight of projectile-----                                    | 4.2 ounces.  |
| Weight of filling (magnesium<br>foil and penthrite wax)----- | 106 grains.  |
| Trace-----   | Pale green, burning statically<br>for 6.4 seconds.   |
| Markings-----  | Annulus black; projectile yellow<br>with black band. |
- e. Armor-piercing/high-explosive tracer.*
- |                           |  |
|---------------------------|--|
| Weight of projectile----- | 5.2 ounces.  |
| Fuze-----                 | Base (pierced striker and flash<br>pellet; detonator held on<br>shear wire). |
| Filling-----              | Penthrite wax.   |
| Identification-----       | Annulus and projectile black.  |
- f. Armor-piercing (sulfur-filling).*
- |  |              |
|--|--------------|
| Weight of complete round-----                | 11.3 ounces. |
| Length of complete round-----                | 8 inches.    |
| Weight of propellant-----                    | 1.29 ounces. |
| Weight of projectile-----                    | 5.2 ounces.  |
| Weight of filling (sulfur—<br>“insert”)----- | 55 grains.   |

Trace----- Pale green, burning statically for 2.5 seconds.

Markings----- Annulus black; projectile black with yellow band; the letter "O" stenciled in white above yellow band.

*g. Armor-piercing incendiary tracer (phosphorous filling).*

Weight of complete round----- 11.3 ounces.

Length of complete round----- 8 inches.

Weight of propellant----- 1.29 ounces.

Weight of projectile----- 5.2 ounces.

Weight of filling (phosphorous which ignites on impact, with small incendiary effect)----- 42 grains.

Trace----- Pale green, burning statically for 2.5 seconds.

Markings----- Annulus and projectile black with yellow band above driving band; the letters "Ph" stenciled in white above yellow band.

*h. Armor-piercing tracer (sulphur filling) with red tips.*

Weight of complete round----- 11.34 ounces.

Length of complete round----- 8 inches.

Weight of propellant----- 1.3 ounces.

Weight of projectile----- 5.2 ounces.

Weight of filling (sulfur—"inert")----- 52 grains.

Trace----- Bright green changing to red (this shell is used to aid ranging on moving targets).

Markings----- Annulus and projectile black with yellow band; the letter "O" stenciled in white above yellow band; point of shell sprayed with red enamel for 10 mm.

*i. Armor-piercing 40 shot.*—This is the 2-cm version of the characteristic armor-piercing 40 ammunition. Such projectiles have a tungsten carbide core and high armor-piercing performance at short ranges.

*j. Practice ammunition.*—The following types are in service:

High-explosive tracer (practice).

High-explosive (practice).

Armor-piercing tracer (practice).

Armor-piercing (practice).

**66. Range table and trajectory chart.**—*a. Range table for ground shooting with armor-piercing shell.*—Muzzle velocity=2,625 feet per second; jump= $\frac{3}{16}^\circ$  in elevation;  $\frac{1}{16}^\circ$  in bearing (to left) (see par. 43, note 15, and fig. 33).

Range (yards)	Quadrant elevation (degrees)	Angle of fall (degrees)	Range to max- imum ordi- nate (yards)	Maximum ordinate (feet)	Time of flight (seconds)	Remaining velocity (feet per second)
110	$-\frac{3}{16}$	$\frac{1}{16}$	55	0. 07	0. 12	2, 470
220	$-\frac{3}{16}$	$\frac{3}{16}$	112	. 26	. 26	2, 315
330	$-\frac{1}{16}$	$\frac{3}{16}$	168	. 66	. 40	2, 160
440	0	$\frac{4}{16}$	229	1. 21	. 55	2, 010
550	$\frac{1}{16}$	$\frac{5}{16}$	288	2. 00	. 71	1, 880
660	$\frac{3}{16}$	$\frac{7}{16}$	352	3. 05	. 89	1, 745
770	$\frac{3}{16}$	$\frac{8}{16}$	416	4. 46	1. 08	1, 625
880	$\frac{4}{16}$	$\frac{11}{16}$	480	6. 27	1. 28	1, 520
990	$\frac{5}{16}$	$\frac{13}{16}$	545	8. 50	1. 49	1, 415
1, 100	$\frac{7}{16}$	1	612	11. 58	1. 72	1, 320

*b. High-angle trajectory chart.*—Figure 52 is a high-angle trajectory chart for the 2-cm Flak 30. The chart is made for ammunition with a muzzle velocity of 2,950 feet per second and a projectile weight of 0.253 pound.



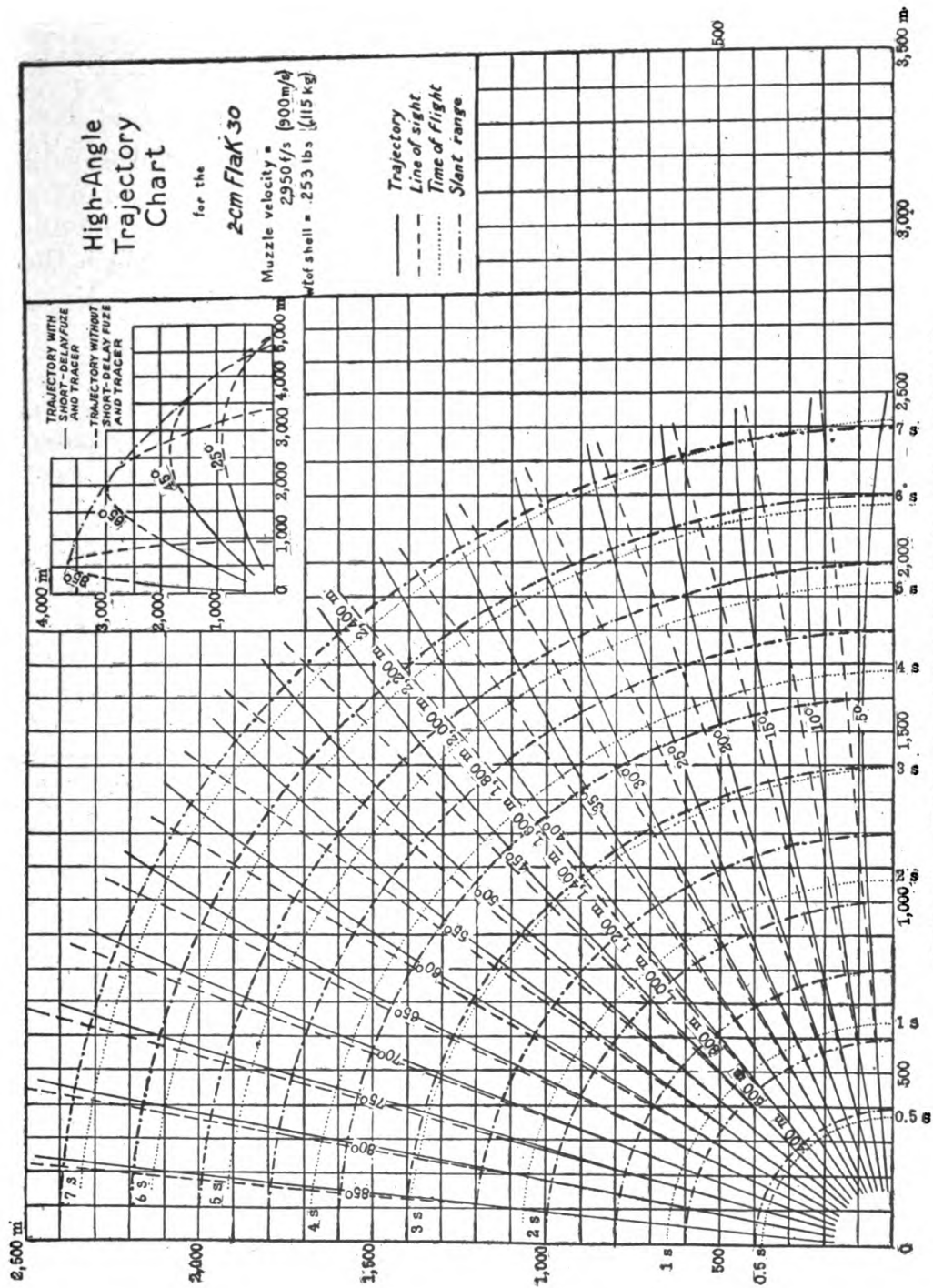


FIGURE 52.—High-angle trajectory chart for the 2-cm Flak 30.

## SECTION XIII

## MATÉRIEL AFFECTED BY GAS

	Paragraph
Protective measures.....	67
Cleaning.....	68
Decontamination.....	69

**67. Protective measures.**—*a.* When matériel is in constant danger of gas attack, unpainted metal parts will be lightly coated with engine oil. Instruments are included among the items to be protected by oil from chemical clouds or chemical shells, but ammunition is excluded. Care will be taken that the oil does not touch the optical parts of instruments or the leather or canvas fittings. Matériel not in use will be protected with covers as far as possible. Ammunition will be kept in sealed containers.

*b.* Ordinary fabrics offer practically no protection against mustard gas or lewisite. Rubber and oilcloth, for example, will be penetrated within a short time. The longer the period during which these articles are exposed, the greater the danger of wearing them. Rubber boots worn in an area contaminated with mustard gas may offer a grave danger to men who wear them several days after the bombardment. Impermeable clothing will resist penetration more than an hour, but should not be worn for a longer time.

**68. Cleaning.**—*a.* All unpainted metal parts of matériel that have been exposed to any gas except mustard and lewisite must be cleaned as soon as possible with solvent, dry-cleaning, or alcohol, denatured, and wiped dry. All parts should then be coated with engine oil. The using arms will decontaminate the exterior surfaces, the bore, the breechlock assembly, and all porous attachments, such as straps, covers, etc., of artillery field pieces exposed to gas.

*b.* Ammunition which has been exposed to gas must be thoroughly cleaned before it can be fired. To clean ammunition, use agent, decontaminating, noncorrosive, or if this is not available, use strong soap and cool water. After cleaning, wipe all ammunition dry with clean rags. *Do not use dry powdered agent, decontaminating (chloride of lime)* (which is used for decontaminating certain types of matériel on or near ammunition supplies), as flaming occurs through the use of chloride of lime on liquid mustard.

**69. Decontamination.**—For the removal of liquid chemicals (mustard, lewisite, etc.) from matériel, the following steps should be taken:

*a. Protective measures.*—(1) For all of these operations, a complete suit of impermeable clothing and a service gas mask will be worn.

Immediately after removal of the suit, a thorough bath with soap and water (preferably hot) must be taken. If any skin areas have come in contact with mustard, if even a very small drop of mustard gets into the eye, or if the vapor of mustard has been inhaled, it is imperative that complete first-aid measures be given within 20 to 30 minutes after exposure. First-aid instructions are given in TM 9-850 and FM 21-40.

(2) Garments exposed to mustard will be decontaminated. If the impermeable clothing has been exposed to vapor only, it may be decontaminated by hanging in the open air, preferably in sunlight, for several days. It may also be cleaned by steaming for 2 hours. If the impermeable clothing has been contaminated with liquid mustard, steaming for 6 to 8 hours will be required. Various kinds of steaming devices can be improvised from materials available in the field.

*b. Procedure.*—(1) Commence by freeing matériel of dirt through the use of sticks, rags, etc., which must be burned or buried immediately after this operation.

(2) If the surface of the matériel is coated with grease or heavy oil, this grease or oil should be removed before decontamination is begun. Solvent, dry-cleaning, or other available solvents for oil should be used with rags attached to ends of sticks.

(3) Decontaminate the painted surfaces of the matériel with bleaching solution made by mixing one part of agent, decontaminating (chloride of lime), with one part of water. This solution should be swabbed over all surfaces. Wash them off thoroughly with water; then dry and oil them.

(4) All unpainted metal parts and instruments exposed to mustard or lewisite must be decontaminated with agent, decontaminating, noncorrosive, by mixing 1 part of solid to 15 parts of solvent (acetylene tetrachloride). If this agent is not available, use warm water and soap. Bleaching solution must not be used, because of its corrosive action. Instrument lenses may be cleaned only with paper, lens tissue, with the use of a small amount of alcohol, ethyl. Coat all metal surfaces lightly with engine oil.

(5) In the event that agent, decontaminating (chloride of lime), is not available, matériel may be temporarily cleaned with large volumes of hot water. However, mustard lying in joints or in leather or canvas webbing is not removed by this procedure, and will remain a constant source of danger until the matériel can be properly decontaminated. All mustard washed from matériel in this manner lies unchanged on the ground, making it necessary that the contaminated area be plainly marked with warning signs before abandonment.

(6) The cleaning or decontaminating of matériel contaminated

with lewisite will wash arsenic compounds into the soil, poisoning many water supplies in the locality for either men or animals.

(7) Leather or canvas webbing that has been contaminated should be scrubbed thoroughly with bleaching solution. In the event that this treatment is insufficient, it may be necessary to burn or bury such matériel.

(8) Detailed information on decontamination is contained in FM 21-40, TM 9-850, and Training Circular No. 38, War Department, 1941.

## APPENDIX

### GLOSSARY

The following list gives in alphabetical order all the German technical terms used in this manual.

Abdeckblech.....	removable cover plate.
Abfeuerungsbügel.....	firing guard.
Abgangsfehlerwinkel.....	jump.
Abgangswinkel.....	quadrant angle of departure.
Abschlussmutter.....	female screw.
Abweiser.....	guard.
Abzugsschiene.....	trigger bar.
Abzugsvorrichtung.....	firing mechanism.
Abzugswelle.....	firing rod.
Anschlag.....	stop, lug.
Anschluss.....	coupling.
Anschlussgetriebe.....	connecting gear.
Aufhängehaken.....	suspension hooks.
Aufnahme.....	tube.
Aufnahmearm.....	receiving arm.
Aufnahmeöffnung.....	opening.
Aufsatzwinkel.....	superelevation.
Ausgleicher.....	equilibrator.
Ausnehmung.....	pedestal bearing.
Ausschnitt.....	cutaway.
Ausserwand.....	outer plate.
Batteriekasten.....	battery box.
Blattfeder.....	leaf spring.
Böckchen.....	support.
Bodenstückbolzen.....	breechblock bolt.
Bremshalter.....	brake holder.
Büchse.....	collar.
Dauerfeuer.....	continuous fire.

Deckblech	cover plate.
Deckel	cover.
Dosenlibelle	spirit level.
Drehring	rotating ring.
Dreiecksverband	triangular structure.
Druckring	pressure ring.
Durchtrittsöffnung	cutaway.
Einzelfeuer	single-shot fire.
Erhöhungsbereich	arc of elevation.
Erhöhungswinkel	quadrant elevation.
Federkopf	spring stud.
Feuer	fire.
Flakvierling	four-barreled antiaircraft mount.
Flakvisier	antiaircraft sight.
Flügelmutter	wing nut.
Flugneigungswinkel	angle of flight.
Flugweg	path of flight.
Führung	sleeve.
Führungsschiene	guide rail.
Führungszapfen	guide pin.
Fusshebel	pedal.
Fussstütze	footrest.
Gabelkopf	bracket head.
Gehäuse	housing.
Geländewinkel	angle of sight.
Gelenkwelle	drive shaft.
Geschossflugzeit	time of flight of projectile.
Geschütznullpunkt	position of gun at instant of firing.
Geschwindigkeit des Flug- zieles.	speed of target.
Gleitschiene	guide rail.
Griff	handle.
Grundplatte	base plate.
Gummiplatte	rubber pad.
Haltebolzen	retaining bolt.
Halteöse	holding eye.
Haltegriff	stop handle.
Halter	holder.
Handfalle	hand catch.
Handrad	handwheel.
Haube	hood.
Hebel	lever.
Höhenrichgetriebe	elevating gear.

# ORDNANCE DEPARTMENT

Höhenrichtgradbogen.....	graduated quadrant of elevating device.
Höhenrichtmaschine.....	elevating mechanism.
Höhenwinkelverbesserungs- knopf.	vertical correction knob.
Holzfutter.....	wooden shelf.
Holzleiste.....	wooden strip.
Horizontalflug.....	horizontal flight.
Horizontierungsgriff.....	leveling handle.
Horizontierungsspindel.....	leveling shaft.
Horizontierungsvorrich- tung.	leveling device.
Hülsenkasten.....	deflector box.
Innerwand.....	inner plate.
Kettenwinde.....	chain winch.
Klappe.....	lid.
Klemmstück.....	clamping piece.
Klemmvorrichtung.....	clamping gear.
Kreuzlochschraube.....	cross hole screw.
Kugelhalter.....	thrust collar.
Kugellager.....	ball bearing.
Kupplung.....	clutch.
Kurbel.....	crank.
Kurbelarm.....	crank arm.
Kurvenscheibe.....	cam plate.
Kurvenwelle.....	camshaft.
Ladesitz.....	loader's seat.
Lafettendreieck.....	triangular base, lower carriage.
Lafettenkasten.....	trail box.
Lager.....	bearing.
Lagerbock.....	coupling recess.
Lagerbügel.....	bearing guard.
Linealvisier.....	linear sight.
Magazinlager.....	magazine rack.
Messentfernung.....	slant range at instant of firing.
Messpunkt.....	present position of target.
Mitnehmer.....	carrier.
Nase.....	lug.
Oberlafette.....	upper carriage.
Plattform.....	platform.
Plattformhälfte.....	platform half.
Protzöse.....	lunette.
Quadrantenfläche.....	quadrant surface.



Querrohr	cross tube.
Rahmen	frame.
Raste	notch.
Rastgriff	stop handle.
Rasthebel	safety catch.
Rastloch	stop hole.
Raststellung	rest position.
Regenschutzkappe	cover for protection against rain.
Richtsitz	layer's seat.
Riegelbolzen	retaining bolt.
Ritzel	pinion.
Ritzelwelle	pinion shaft or rod.
Rückenblech	back rest plate.
Rückenlehne	back rest.
Rückhofeder	recuperator spring.
Rücklaufeinrichtung	recoil mechanism.
Rutschblech	slide plate.
Schaltkasten	switch box.
Schlitten	sleigh.
Schusswinkel	angle of departure.
Schutzdeckel	protecting cover.
Schutzkappe	protecting cap.
Schutzkasten	protecting box.
Schutzrichtung	line of fire.
Schutzring	protecting ring.
Schutzschild	protecting shield.
Schwenkarm	bracket arm.
Sechskanteschraube	hexagonal screw.
Seilrolle	cable pulley.
Seilrollenträger	cable drum bracket.
Seilscheibe	cable pulley disk.
Seilzug	cable pulley unit.
Seitenabweichung	drift.
Seitenrichtbereich	extent of traverse.
Seitenrichtgetriebe	traversing gear.
Seitenrichtmaschine	traversing mechanism.
Seitenteilring	azimuth scale.
Seitentrieb	traversing gear.
Seitentriebgehäuse	traversing gear housing.
Seitenwinkelverbesserungs- knopf.	lateral correction knob.
sicher	safe.
Sicherungsblech	safety plate.

# ORDNANCE DEPARTMENT

Sitzarm	seat rest.
Sitzbein	seat leg.
Sonderanhänger	special trailer.
Spannfeder	tension spring.
Spannschloss	turnbuckle.
Sperre	lock.
Sperrhebel	locking lever.
Spiralfeder	spiral spring.
Spiralfedersatz	spiral spring assembly.
Splint	cotter.
Staubdeckel	dust cover.
Steuerstange	control rod.
Störkreis	traverse arc.
Sturzflug	path of dive.
Tachodynamo	electric generator.
Tachokasten	electric generator box.
Träger	carrier, bracket.
Tragzapfen	carrier pin.
Treffpunkt	future position of target.
Treffpunktentfernung	slant range to future position of target.
Trommel	drum.
T-Stück	T-piece.
Überzugsfeder	control spring.
Umlenkrolle	deflecting pulley.
Umstellhebel	reversing lever.
Unterbrecherhebel	interrupter lever.
Visierkopf	sight head.
Visierrichtung	line of sight.
Visierschild	sight shield.
Visierträger	sight bracket.
Vorderwand	front plate.
Waffe	weapon, gun.
Waffenaufnahme	gun holder.
Waffengehäuse	gun housing.
Welle	shaft.
Wiege	cradle.
Winkel	angle.
Winkelhebel	angle lever.
Winkelring	angle ring.
Winkelstock	bent rod.
Zahnbogen	elevating rack.
Zahnkranz	traversing rack.

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Zahnrad	-----	gear wheel.
Zielfernrohr	-----	telescopic sight.
Zugstange	-----	pull rod.
Zunge	-----	tongue.
Zurrbolzen	-----	locking pin.
Zurrhaken	-----	locking hook.
Zurrmarken	-----	locking marks.
Zurrstellung	-----	locked position.
Zurrung	-----	locking mechanism.
Zusatsfeder	-----	tension spring.
Zwischenwelle	-----	intermediate shaft.



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[A. G. 062.11 (8-14-42).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,  
*Chief of Staff.*

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(For explanation of symbols, see FM 21-6).



